SCIENCE

FRIDAY, MAY 26, 1916

CONTENTS

The Volcanic History of Lassen Peak: J. S. DILLER 727

The Need for More Horticultural Research: PROFESSOR W. L. HOWARD 733

Report of the Treasurer and Permanent Secretary of the American Association for the Advancement of Science 737

Scientific Notes and News 739

University and Educational News 742

Discussion and Correspondence:—
Conservatio Virium vivarum: DR. GEORGE F. BECKER. *Serpent Dread in the Primate Family:* PROFESSOR ARTHUR M. MILLER, DR. ARTHUR E. BOSTWICK 743

Scientific Books:—
Autenrieth's Manual for the Detection of Poisons: PROFESSOR E. M. CHAMOT. *Taylor's The Chemistry of Colloids, Ostwald's Handbook of Colloidal Chemistry:* PROFESSOR WALTER A. PATRICK. *Hewitt on the House Fly:* W. D. HUNTER 745

Contributions to Mineralogy and the Mineral Springs of Japan: DR. GEORGE F. KUNZ... 748

Special Articles:—
Antagonistic Electrolyte Effects in Physical and Biological Systems: DR. G. H. A. CLOWES 750

The Organization of the Pacific Physical Society: PROFESSOR RALPH S. MINOR 757

Societies and Academies:—
The American Mathematical Society: PROFESSOR F. N. COLE. *The Biological Society of Washington:* DR. M. W. LYON, JR. 760

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE VOLCANIC HISTORY OF LASSEN PEAK[1]

WILL there be another great volcanic explosion from the summit of Lassen Peak this spring? is a burning question among those scientists who are studying the recent performance of that old volcano. A feeble explosion May 30, 1914, opened a new period of volcanic play, and on May 19 and 22, 1915, the greatest and most devastating eruptions occurred. As these dates are about the time of maximum annual snow-melts at Lassen Peak, they suggest a causal relation to the volcanic activity. If so, perhaps another large eruption may be due in May, 1916, and throw more light on the volcanic problem.

Lassen Peak is in northeast California and forms the southern end of the Cascade Range. It stands between the northern end of the Sierra Nevada and the Klamath Mountains, a mighty volcano that rises to an elevation of more than a mile above the early Tertiary and Cretaceous sedimentary rocks on which it rests. It is on the edge of one of the greatest lava fields in the world, extending from northern California, Oregon and Washington eastward across Idaho into the Yellowstone National Park of Wyoming, and covering an area of about 250,000 square miles. Over the eastern portion of this field most of the lava is basalt, which was very liquid at the time of its eruption and, spreading far and wide like water, it formed a flattish country, the great plains of Snake River and the Columbia, but along the western border the lava

[1] Published by permission of Director of U. S. Geological Survey.

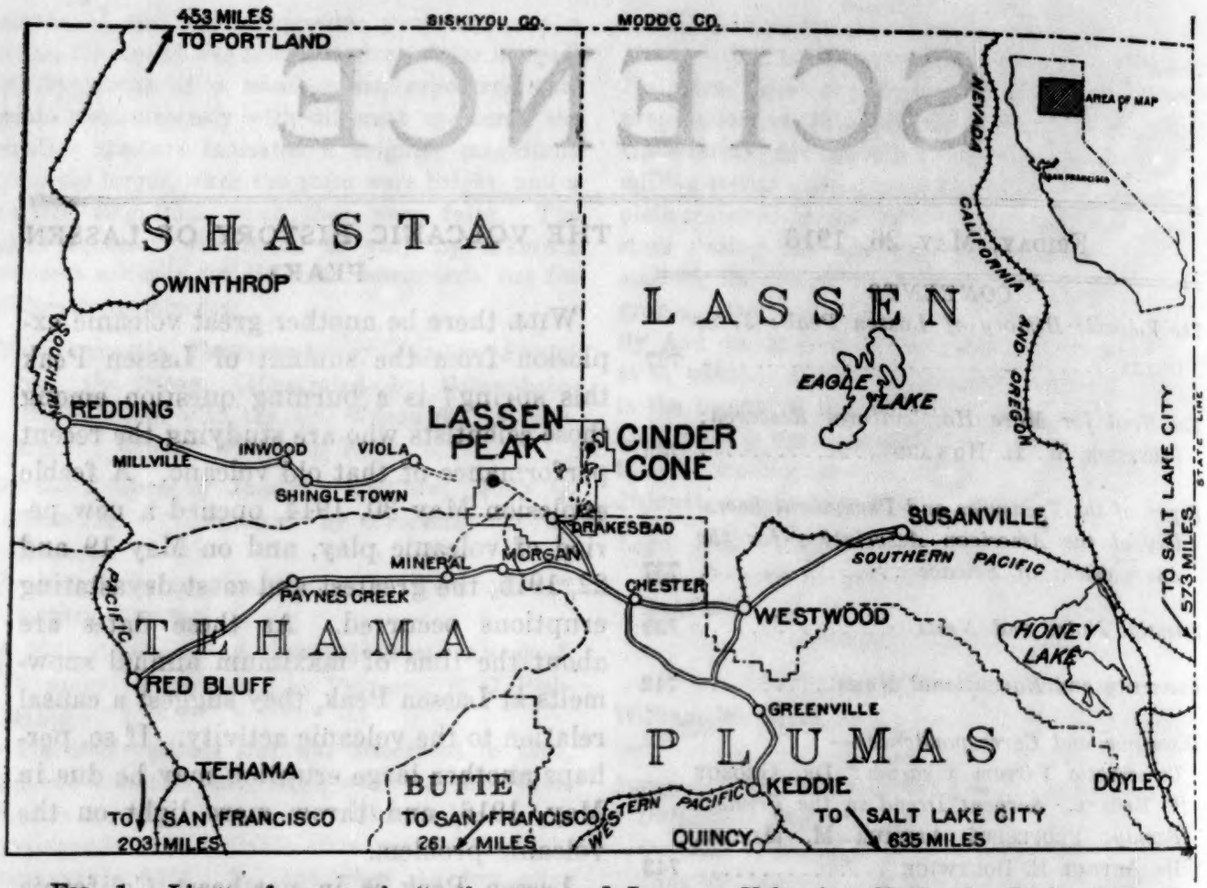

FIG. 1. Lines of approach to the proposed Lassen Volcanic National Park Railroads, wagon roads and trails to Lassen Peak and cinder cone, which are 10 miles apart and within the boundary of the proposed park.

is chiefly andesite, a viscous lava that piled up about the vents from which it issued and built up a range, the Cascade range, surmounted by great peaks, from Lassen Peak, which rises 10,460 feet, to Shasta and Rainier, that attain an elevation of more than 14,000 feet.

In the volcanic belt of the Alaskan Coast there are a number of vigorously active volcanoes. So also in Central America and Mexico, but in the Cascade range the volcanoes appear to be near extinction.

Since the white man settled on our Pacific coast there has been but little volcanic activity. In 1843, about the time Fremont, the pathfinder, made his memorable trip across the continent, Mount Baker and Mount St. Helens in the state of Washington were both in eruption, spreading a blanket of volcanic dust over the country as far south as the Columbia, where at the Dallas a missionary gave a sample to Fremont.

Professor Davidson, of the United States Coast Survey, in 1854 saw an eruption of Mount Baker. The summit was obscured by vast rolling masses of dense smoke, which in a few moments reached an estimated height of two thousand feet above the summit and soon enveloped it entirely. In 1858 Mr. J. S. Hittell saw the clouds over Mount Baker brilliantly illuminated by an eruption then taking place.[2]

Mount Rainier and Mount Shasta emit heated vapors from the fumaroles on their summits, giving evidence that their interiors are still hot.

[2] "The United States," J. D. Whitney, p. 115.

The present activity of Lassen Peak, though feeble as compared with its earlier eruptions, is proof that it must still be classed as an active volcano.

The volcanic activity which resulted in the upbuilding of Lassen Peak began near the close of the Eocene. The lava flows appear to have been largest and most numerous in the Miocene and Pliocene, successive flows decreasing in size during the Quaternary to near extinction in recent times.

There were long periods of interrupted activity separated by long intervals of quiescence. During the active periods both explosive and effusive eruptions were common; the one forming cinder cones and sheets of volcanic agglomerate and tuff; the other forming lava fields whose ruggedness was proportional to the viscosity of the erupting lava.

Lassen Peak is a volcano of large type surrounded by many smaller ones of later date, the whole being built up of a notable variety of lavas. The oldest lavas of the Lassen Peak region are of intermediate chemical composition belonging to andesites. The early magma yielding the erupting andesitic lavas in the course of time differentiated into two portions. On the one hand it became more siliceous (salic), erupting as dacite and rhyolite, and on the other hand it became less siliceous (mafic), yielding basalt and quartz basalt. All varieties are well represented in the Lassen Peak region and are derived apparently from the same magma.

As the volcanic center developed the most active crater migrated. The first crater was in the head of Mill Creek. It was not only the oldest, but also the largest crater, more than a mile in diameter. Composed of andesitic lavas, it rose to a height of 9,400 feet. The peak named "Brokeoff Mountain" on the Forest Service maps is the most prominent remnant of this great crater in the head of Mill Creek.

The second great crater opened on the northern edge of the first and erupted dacite, building up Lassen Peak to its present height with a summit crater about a quarter of a mile in diameter.

The third crater, about four miles a little west of north from the first, opened only a few centuries ago at the northwest base of Lassen Peak, and the rugged lava flows from it formed Chaos Crags.

The products of this eruption in Chaos Crags are well preserved and their relations clearly visible. The eruption began by a succession of explosions that spread a thin layer of volcanic sand and dust over the surrounding country and ended in the extravasation of a most rugged mass of dacite which, though at first glance having the aspect of granite, is rich in volcanic glass, generally of dark color, somewhat pumiceous and full of inclusions like the dacites of Lassen Peak.

The fourth crater of Lassen Peak is the new crater, active at the present time. It began by a slight explosion within the old crater, second of those enumerated, on the summit of Lassen Peak, and is remarkable for its place of outbreak, as well as its low energy, the small mass of material erupted and the continuity of the activity. Like the eruption of a few centuries ago at Chaos Crags, it had two phases, one explosive, the other effusive.

During the first phase the explosive eruptions were of gas carrying out with it rock fragments and dust only. The size of the crater increased with each eruption, as shown in Fig. 2 by the outlines of the new crater June 14, 1914, and March 23, 1915. The second phase, which is effusive, includes also an eruption of lava, which formed a lid on the volcano and overflowed to the west, as represented in Fig. 2.

In the beginning the new crater was confined to the loose material filling the old crater, but later it reached the solid rock

of the old crater rim and finally after more than 150 eruptions it attained near the end of March, 1915, a size of about 700 to 1,000 feet.

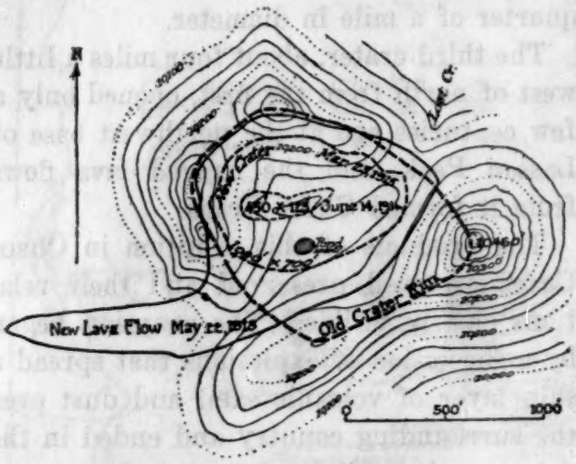

FIG. 2. Sketch contour map of the summit of Lassen Peak by J. M. Howells, June 16, 1914, upon which has been drawn the outline of the old crater rim as well as the outline within it of the enlarging new crater June 14, 1914, and March 23, 1915. The new crater at first lengthened east and west and later widened north and south, in both cases along joint planes, until its dimensions were 1,000′ × 700′. Then the explosive eruptions gradually became effusive. The lava in the throat of the volcano gradually upheaved during April and May until it filled the old crater and overflowed through the lowest notch and down the west slope about 1,000 feet. The hot blast that devastated Hat Creek escaped from beneath the lava lid at the head of Lost Creek.

Ejecta accumulated on the rim of the new crater to a depth of thirty to forty feet. The largest stone ejected was fifteen feet in diameter and weighed about sixty-three tons. Small stones were thrown as much as a mile from the crater, but beyond two miles from the crater scarcely more than a trace of dust could be noticed except to the northeast, the direction of the strongest winds and that taken by the great blast of the eruption May 22, 1915.

By far the greatest eruptions that have occurred at Lassen Peak since its present activity began are those of the night of May 19 and the afternoon of May 22, 1915. The first great result was the extrusion of new lava and the formation of a lava lid which culminated in the second great feature, the devastation of the Lost Creek and Hat Creek country by a horizontal blast of hot gas.

About the end of March, 1915, the old crater having been thoroughly cleaned out by explosive eruptions and the superincumbent load largely removed from the magma, it began to rise in the volcanic conduit and initiated the second stage, the effusive stage, of the volcanic activity. The hot magma apparently more or less viscous in the volcanic conduit, was forced upward by pressure of magma or gas from beneath and was gradually upheaved, with great escape of steam, until it reached the surface as new lava, and as a lava table filled not only the new, but also the old crater so as to form a lid on the volcano. The lava overflowing from the edge of the lid through a notch in the old rim, as shown in Fig. 2, passed down the west slope of Lassen Peak about a thousand feet.

On the night of May 19 and especially also on the afternoon of May 22, 1915, the eruptions were violent. A mushroom-shaped cloud was hurled to the height of about four miles above the summit of the mountain and afforded a magnificent spectacle as seen from the Sacramento Valley. At night[3] flashes of light from the mountain summit, flying rocket-like bodies and cloud glows over the crater reflecting the light from incandescent lavas below were seen by many observers from various points of view and appear to indicate that much of the material erupted was sufficiently hot to be luminous.

[3] Luminous phenomena were reported on the nights of September 29, 1914, May 14, 15, 17 and 19, 1915, as well as June 20 and October 20 of the same year. Some of the phenomena reported may be explained as due to the reflected rays of the setting sun, but this can not be true of all.

Professor R. S. Holway, who was one of the first observers to ascend the mountain after the eruption, saw it on May 27, five days after the eruption, and states that "hissing steam was escaping from many cracks and crevices and the shimmering air above all telling of the hot rocks below."

J. M. Howell's party visited the summit May 30, eight days after the eruption, and Mr. Spaulding reports that

> the heat from the upheaved mass was intense. The air above it shimmered with heat waves like the desert on a boiling summer day.

That the new lava in the lid at the time of its eruption was so hot at least in spots as to be luminous appears evident and it is probable that the temperature to produce luminosity, say 600° to 1,000° C. would at the same time give to the slowly rising lava such a degree of viscosity as to enable it to adjust itself to its surroundings and overflow the crater rim.

Although the lava lid in places appears to be a mass of tumbled rock fragments yet there are large portions of it essentially continuous, as if forced up in viscous condition and broken later as a result of the cooling, flowing and subsidence of the mass within the crater. The postmaster at Manton reports that a change was noticed on the summit of the mountain for a few days previous to May 19. A black wedge-shaped mass of lava appeared in the middle of the new crater, getting higher every day, and finally in plain view spilling over through the notch on the west slope.

Many volcanic bombs were ejected by explosive eruptions during the effusion of the new lava. They range up to five feet or more in diameter and are most abundant at the foot of the steeper portion of the northwest slope. Many of them have a peculiar compact crust with a cracked surface like bread crust, suggesting the name "bread crust bombs," and they are regarded as the luminous ejecta seen in connection with several eruptions by observers from different points of view. No other portion of the erupted magma afforded such impressive evidence of fusion as the bread-crusted bombs.

Although the extrusion of the new lava and the formation of the lava lid was the main feature of the great eruptions in May, it was far surpassed in interest and wonder by the remarkable horizontal eruption of the hot blast that devastated Lost and Hat Creeks.

On the night of May 19, it appears that the body of superheated gases which accumulated beneath the lid, forcing it up, escaped from under the edge with terrific force down the deep snow-covered northeast slope of Lassen Peak toward Lost Creek and Hat Creek. The snow was instantly converted into water, and the mighty onrush of water and blast of hot gases swept everything before it for more than ten miles along Lost Creek, forming a devastated belt from a few hundred yards to a mile in width. Meadows were buried beneath finer débris and occasional large boulders broken off from the edge of the lava lid far above. Trees three feet in diameter were broken off or uprooted and the country scoured as by a mighty sand blast. The fine green leaves of the pine trees left standing along the borders of the blast were killed by the heat and turned brown. Locally, on favorable slopes, the heat was so great that the green leaves were charred. Not only those of the pine, but also those of the Manzanita, several acres of which, at a distance, had the general appearance of an area swept by a forest fire. In fact it is stated by Mr. Fred Seaborn, of the Forest Service, who was in that region a few days later, that two fires were actually kindled by the eruption.

This reminds one of the hot blast from

Mount Pelée that destroyed St. Pierre. Luckily in the Hat Creek region there were only a few summer residents. Warned by the noise of the approaching torrent, they escaped to the hills.

That no one was killed was simply a matter of good fortune on the part of the eleven enthusiasts who early visited the region to make a photographic record. Mr. B. F. Loomis, the veteran photographer of Viola, was among them.

There were two hot blast eruptions into the Hat Creek country; one on the night of May 19 and the other on the afternoon of May 22.

The Loomis party arrived on the scene about noon, May 22, and spent several hours photographing up to the head of Lost Creek, making a record of what was accomplished by the first blast. They left soon after 3 o'clock and had scarcely reached the west side of Chaos Crags when the most violent eruption occurred, sending its column of smoke to a height of more than 20,000 feet, as seen from the Sacramento Valley, and a hot blast down the slope into the Hat Creek country that would probably have killed the whole party had the eruption occurred a few hours earlier.

At the time of the great outbreak a fissure was opened running from the summit northwest about 1,000 feet down the slope toward Chaos Crags. Three vents were opened on this fissure, and the greater portion of the volcanic activity during the summer of 1915 was confined to this fissure. G. W. Olsen, who ascended Lassen Peak October 19, 1915, reported the northwest fissure quiet, but another one active a few hundred feet east of it on the northern rim of the lid.

Fumaroles have developed at a number of points on the north and west slopes of Lassen Peak within 800 feet of the summit, but all the violent eruptions have occurred at or very near the summit. No fumaroles have appeared on the south and east slopes, the direction of easiest approach, where at lower levels, 5,800 to 7,400 feet, fumaroles and solfataras are such active features at Bumpass' Hell, the Devil's Kitchen, and Tartarus or Boiling Lake. These solfataras within three miles of Lassen Peak have been active with but little change during the last fifty years. They are on the strongest side of Lassen Peak and have not been affected by the eruptions at its summit, 4,000 feet above them.

The total mass of material transferred from within the mountain to the surface by the explosive and effusive eruptions during the twenty-two months since the beginning of volcanic activity at the summit of Lassen Peak is very small as compared with the results of volcanic eruptions generally, and yet its small size and high point of activity may be important factors in discovering its cause.

In any discussion as to the cause of the recent eruptions a record of the facts as to time and energy is fundamental.

The Forest Service at Red Bluff, W. J. Rushing in charge, furnished most of the important data during the summer when the rangers were in the field, but at other times Miss Alice Dines, postmaster at Manton, and G. W. Olsen at Chester, both living in sight of the mountain, supplemented the record. The eruptions have been tabulated as to time, intensity and duration, and the tabulation has a more or less evident bearing as to the efficiency of certain causes that may affect the eruptions.

The variation as to time of day at which eruptions occur is very irregular and one time of day appears about as favorable as another for eruption. Of the 220 eruptions up to the end of January, 1916, 143 occurred in the day time, while 77 occurred at night, that is between 7 P.M. and 7 A.M.

In the day time 57 eruptions occurred between 7 and 11 A.M., 40 occurred about noon, between 11 A.M. and 3 P.M., while between 3 and 7 P.M. 46 occurred. It has been supposed that a greater supply of surface water might favor eruption. If that is true, we should expect more frequent eruptions in the late afternoon or early evening when the day's supply of water from melting snow is at its maximum. On the contrary, the mornings have most eruptions, at a time when the daily heat and water supply are near their minimum.

That the volcanic energy is not dependent upon the supply of surface water to form steam is suggested by the fact that summer and autumn, the dry season, with least water, have a greater number (94) of eruptions than (84) the wet season of winter and spring.

In order to determine whether the volcano responds to the tidal wave produced in the crust of the earth by the moon, Mr. Van Orstrand has carefully considered 190 of the best recorded eruptions and concludes that as yet the results are merely suggestive.

If we compare the number of corresponding seasonal eruptions in 1914 and 1915 the result appears significant. In the summer of 1914 there were 38 eruptions, but in 1915 only 17. In the autumn of 1914 there were 56 eruptions, while in 1915 there were only 22. Since the great eruption of May 22, 1915, when the new lava was extruded and the Hat Creek country devastated, the number of eruptions has decreased and the decadence continues, but whether or not the active period of Lassen Peak is approaching its close, although probable, may be more certainly told next summer.

With its comfortably active volcano, inviting cinder cones and lava fields, vigorously boiling hot springs, mud lakes and "mush pots" for the vulcanologist to study, and the glaciated divides and canyons for the physiographer, in a setting of lovely scenery and attractive camps, for the tourists all easily accessible, the Lassen Peak region affords one of the most alluring and instructive spots for a national park.

J. S. DILLER

U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.,
April 18, 1916

THE NEED FOR MORE HORTICULTURAL RESEARCH[1]

IN order to introduce my subject I hope I may be pardoned for digressing a moment. A few years ago while spending a part of a vacation in the Sierras, I climbed from the floor of Yosemite valley to the top of Glacier Point. To those of you who have been there I need not say that this climb required several hours of very severe physical effort. In traveling a mile and a half or less, the vertical ascent amounted to three thousand feet. I was accompanied by my wife, and being mindful of her safety as well as my own, I very naturally chose each step of the climb with great care. Often a contemplated step might look safe enough but, on glancing into the depths below, I would feel the necessity for making a more careful examination of the footing before risking my weight upon it. There were numerous instances when a false step might have sent us both hurtling downward, and it really is not pleasant to contemplate a half-mile drop into space even when accompanied by good company. Sometimes what appeared to be firm soil on a ledge turned out to be sand, or what looked like solid rock proved to be loose stones concealed by moss and lichens. Thus the journey was made without mishap, but slowly, tediously, because

[1] President's address delivered before the twelfth annual meeting of the Society for Horticultural Science, Columbus, Ohio, December 28, 1915.

every step had to be proved before the next one could be made.

Now this little experience in mountain climbing is not unlike that of a man who undertakes to write a bulletin, scientific paper or even to prepare a lecture to deliver in the classroom. Every member of this society has to do some or all of these things every year. And I ask you how often you have tried to make the points of your discussion safe and unassailable by proving every step you took. Take almost any subject in horticulture, no matter how commonplace, and how far can you proceed with your task if you try to make all of your statements square with proven facts? Don't you find that every few steps you discover, upon close examination, that what looks to be firm ground turns out to be loose sand and rolling stones? Facts are usually things that have been experimentally proven. Many of the accepted facts of horticulture—statements that are repeated over and over because others have used them, until they have found their way into respectable literature—too often turn out, when subjected to the acid test of careful inquiry, to be mere theories or opinions.

Granting that many of the things we give our students every day as facts are really truths that have been learned by long experience or general observation, I ask if it is not high time that we cultivate the habit of proving our statements by submitting the evidence. But, you object, we would never be able to get anywhere in a discussion—that it is out of the question to try to prove everything we say. And unfortunately this is too true, which brings me to the real subject of my remarks, viz., the great, I might almost say, the crying need, for more horticultural research.

I am using the word research here in a very broad sense, so that it may include all kinds of experimental work. Correctly speaking, an experiment is an act or operation designed to discover, test or illustrate some truth, particularly by arranging the elements or essential features of some object or process so as to permit of controlled observation, as variety tests of fruits and vegetables, pruning tests of trees or fertilizer tests with growing plants. Researeh, on the other hand, is diligent, protracted investigation for the purpose of adding to human knowledge. The ultimate aim of real research is the discovery of natural laws and fundamental truths. Research may, and probably will, include many experimental tests, but the aims of an investigator should reach much farther than the bare results of any tests. The experiments may be regarded as mere steps in an investigation. There appears to be a widespread belief that research means something impractical, that it can seldom or never be engaged in with direct profit to a state. Even some station directors—though happily they are in the minority—seem to hold this view.

I do not for a moment underestimate the value of experimental work. Every horticultural department should have as many experimental projects as can be handled. In this way many theories can be tested and a very great many practical questions answered. Still, some dangers may lie concealed along the experimental way, for in the very nature of things there are questions and problems that can not be answered or solved by experimentation alone. Perhaps the chief danger is the predilection for drawing unwarranted conclusions from simple tests. Also students and very young station men may be misled into believing that they are investigating when they are only experimenting, and this may be fatal to their potential future usefulness.

I can not refrain from prolonging this part of the discussion by saying that investigational work may be the most practical kind of activity that men may engage in. To cite a field of inquiry in which I may claim more or less acquaintance, I may say that the problem of the rest period of plants—while an investigation seeming on its face to serve no practical purpose, has already been found to shed light on the very live and very practical question of hardiness of fruits in cold climates. And in warm climates, particularly under semi-arid conditions, I am convinced that it will eventually serve as a foundation stone on which to establish irrigation and pruning practises as applied to deciduous fruit trees. Both pomological and irrigation divisions are now carrying on experiments, independently and cooperatively, to determine these things, but I greatly fear that all present efforts are only scratching the surface of the one great question of orchard fruitfulness.

But I have wandered away from my subject as I had meant to discuss it. What I started out to say was that we need more facts pertaining to horticultural questions. Not only should more problems be investigated in an experimental way, but whenever a piece of work is carried out, no matter how small it may be, should we not bend every energy toward establishing each and every step so securely that all will endure the wear and tear of the multitude of other workers who may desire to climb toward other things over the secure stones that we have laid? Let us not despise experiments with commonplace things just because others have been content to pass them by on the strength of current statements (unsupported by experimental proof of any kind) which say that it is best—yea even vitally necessary—to do thus and so, if certain results are to be attained.

I wish I had time to submit a full list of the common things teachers of horticulture have to discuss without being able to offer evidence that would pass muster in a justice's court. However, I shall have to be content with a few random shots that occur to me on the spur of the moment: In graftage what is meant by an uncongenial stock or lack of affinity between scion and stock? What happens when a bud with its adhering piece of bark is inserted beneath the bark of a stock? Does each part possess a complete cambium layer or each only half a layer? In healing wounds how are two outer bark surfaces, upon meeting, enabled to grow together? What relation does callusing bear to root formation in cuttings? Where can we find some reliable quantitative comparisons of tops and root systems of fruit trees? How does branch pruning affect the root system of trees? Is there a corresponding root for each vigorous new water sprout? What do we really know about the secret of fruitfulness in trees, particularly the fruiting habit? Why do so many apple trees bear on alternate years? Why can not Ben Davis and Baldwin, for example, be made to bear annually? Why is it an apple tree may bear fruit buds enough for a "full" bloom and only ten per cent. really open in spring? What is the true effect of sunlight on fruit bud formation? What are the causes of growth periodicity in trees and the relation of same, if any, to fruit-bud formation? What is "hardiness" in trees and buds? What is the nature and cause of coloring in apples? What do we know about the value of selecting buds in deciduous trees? Is "pedigree" in trees a humbug? Why do certain individual trees appear to have a superior record for fruitfulness? What is meant by vigor in trees? What is the true cause of "June drop" in fruit trees? And so on and so on; all of which makes us painfully

aware of the fact that there are a world of things appertaining to common practises which we know little about. But this lack of knowledge should not discourage us, as was the case of the fond parent in the story who put his son through a seven years' medical college course and then was thoroughly disgusted because the young man couldn't tell him how to cure a wart.

On the other hand, we should be stimulated to greater effort in seeking out facts for ourselves and we should not ignore too many of the little things just because they may seem commonplace. If a young man wants a problem he need not look far to find one. But let us get away from stereotyped statements and try to acquire a new stock of first-hand information.

Somehow or other our horticultural literature has gradually become permeated with dogmatic statements and unsupported opinions which our students are permitted to absorb as gospel truths. Who is to blame for this I can not say and I fear it would not be profitable to try to place the blame. Conditions are probably responsible for the most part in bringing about this state of affairs. For horticulture is one of the oldest of the agricultural groups recognized by the colleges and stations. Without any experimental facts at their disposal and with few or no facilities for securing experimental information, men were called upon to give instruction in fruit-growing and gardening and they met the situation as best they could by drawing upon their own practical experience or the experience of horticultural friends and did their best to explain why certain things had to be done so and so, even though it sometimes became necessary to draw heavily upon their imagination. But, in the language of the day, they "got away with it" and some of us have continued, more or less, to keep up the practise.

Reform, however, is coming about and coming from a source least expected, viz., from the students that we have to teach. With the rapid raising of standards for entrance in the agricultural colleges, came a class of students with good fundamental training who refused to accept the time-honored statements so general in horticulture without at least plausible explanations. I feel certain that this has been the chief force that has broken the old traditions and is bringing about a brand-new horticulture. I am sure a brighter day is dawning and that we shall soon be free from all the hampering fetters of the past.

One reason for my cheerfulness regarding the horticultural situation is the result of an inquiry which I recently addressed to all the experiment stations in the United States. Since there is somewhat of a scarcity of reliable horticultural literature along many lines, I greatly feared that administrative officials might be placing better facilities at the disposal of their departments of chemistry, botany, etc., but I find that apparently such is not the case. My findings show that approximately half of the stations of the United States have one or more officials in horticulture designated as research men, but that eighteen per cent. of these persons do some teaching. However, I did not learn the nature of this teaching. If it is a limited amount of graduate or upper class instruction the men will be all the better investigators, but with too much lower class work their research titles may become a farce. Station directors often reported men as doing no teaching while the men themselves said that under stress of circumstances they were compelled to do a considerable amount of teaching. Deans and directors are sometimes great "boosters." From incomplete replies representing thirty or thirty-five institutions, it appears that horticulture is fully as well represented by

research men as other departments of the stations.

An effort was made to find if the output of horticultural bulletins is as great as from other departments, but this part of the inquiry was a failure. Of the nearly 200 "official" horticultural projects now under way in the various stations, about eleven per cent. are Adams Fund investigations and over thirty per cent. of the others are regarded as being of research grade.

In conclusion I may add that it appears that the whole range of horticulture from floriculture to pomology now seems to be as well manned as other departments, and if the next few years does not see a greatly increased output of reliable literature, then we are not living up to our opportunities.

W. L. HOWARD

UNIVERSITY FARM,
DAVIS, CAL.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORT OF THE TREASURER, 1914

IN compliance with Article 15 of the Constitution, and by direction of the Council, I have the honor to submit the following report, showing receipts, disbursements and disposition of funds of the association for the year ending December 31, 1914.

Receipts have come into the keeping of the treasurer from one source, namely, interest on funds deposited in savings banks. The total amount of this interest is $935.49.

Disbursements made in accordance with the direction of the council amount in the aggregate to $448.67.

The total amount of funds of the association deposited in banks and subject to the order of the treasurer December 31, 1914, is $30,138.20.

The details of receipts, disbursements and disposition of funds are shown in the following itemized statement.

R. S. WOODWARD,
Treasurer

April 1, 1914

The Treasurer in Account with the American Association for the Advancement of Science

DR.

1914		
Jan. 1.		
To balance from last account		$29,651.38
To interest on funds in banks as follows:		
Cambridge Savings Bank, Cambridge, Mass.	$46.41	
Emigrant Industrial Savings Bank, New York, N. Y.	120.00	
Metropolitan Savings Bank, New York, N. Y.	105.00	
Union Square Savings Bank, New York, N. Y.	105.00	
U. S. Trust Co., New York, N. Y.	499.68	
Munsey Trust Co., Washington, D. C.	59.40	935.49
Total		$30,586.87

CR.

1914.		
Dec. 3.		
By interest paid on 252 life memberships		$398.67
Dec. 4.		
By one life membership under Jane M. Smith Fund		50.00
By cash in banks as follows:		
Cambridge Savings Bank, Cambridge, Mass.	$1,066.81	
Emigrant Industrial Savings Bank, New York, N. Y.	3,120.00	
Metropolitan Savings Bank, New York, N. Y.	3,105.00	
Union Square Savings Bank, New York, N. Y.	3,105.00	
U. S. Trust Co., New York, N. Y.	19,613.78	
Fifth Avenue Bank of New York, N. Y.	127.61	30,138.20
Total		$30.586.87

I hereby certify that the foregoing account is correctly cast and properly vouched.

HERBERT A. GILL,
Auditor

1915

In compliance with Article 15 of the constitution, and by direction of the council, I have the honor to submit the following report showing receipts, disbursements and disposition of funds of the association for the year ending December 31, 1915.

Receipts have come into the keeping of the treasurer from two sources, namely, from life membership commutations and from interest on invested funds. The total amount of these receipts is $1,403.14.

Disbursements made in accordance with the direction of the council amount to an aggregate of $900.

The total amount of funds of the association deposited in banks and subject to the order of the treasurer December 31, 1915, is $30,641.34.

The details of receipts, disbursements and disposition of funds are shown in the following itemized statement.

R. S. WOODWARD,
Treasurer

April 1, 1915

The Treasurer in Account with the American Association for the Advancement of Science

DR.

1915.		
Jan. 1.		
To balance from last account		$30,138.20
Jan. 27.		
To 10⅔ life memberships		530.00
Dec. 31.		
To interest received on funds in banks as follows:		
Cambridge Savings Bank, Cambridge, Mass.	$45.81	
Emigrant Industrial Savings Bank, New York, N. Y.	120.00	
Metropolitan Savings Bank, New York, N. Y.	120.00	
Union Square Savings Bank, New York, N. Y.	105.00	
U. S. Trust Co., New York, N. Y.	482.33	873.14
Total		$31,541.34

1915. CR.

Jan. 19.		
By grant paid Alfred Dachnowski		$150.00
By grant paid Concilium Bibliographicum		400.00
April 10.		
By 2 life memberships under Jane M. Smith fund		100.00
May 4.		
By grant paid Lyman Briggs		250.00
Dec. 31.		
By cash in banks as follows:		
Cambridge Savings Bank, Cambridge, Mass.	$1,112.62	
Emigrant Industrial Savings Bank, New York, N. Y.	3,120.00	
Metropolitan Savings Bank, New York, N. Y.	3,120.00	
Union Square Savings Bank, New York, N. Y.	3,105.00	
U. S. Trust Co., New York, N. Y.	19,296.11	
Fifth Avenue Bank of New York, N. Y.	887.61	30,641.34
Total		$31,541.34

I hereby certify that the foregoing account is correctly cast and properly vouched.

HERBERT A. GILL,
Auditor

WASHINGTON, D. C.,
April 1, 1916

REPORT OF THE SECRETARY

L. O. Howard, Permanent Secretary, in Account with the American Association for the Advancement of Science from November 1, 1914 to October 31, 1915

DR.

To balance from last account		$7,095.74
To receipts from members:		
Annual dues, 1915	$22,184.00	
Annual dues, 1916	100.00	
Annual dues, previous year.	372.00	
Admission fees	2,305.00	
Associate membership fees.	24.00	
Life membership fees	570.00	25,555.00
To other receipts:		
Sale of publications	19.20	
Treasurer's payment towards subscriptions to SCIENCE for life members	398.67	
Bequest from R. T. Colburn estate	750.00	
Miscellaneous receipts, including postage, sale of programs, and interest	348.85	1,516.72
		$34,167.46

The foregoing account has been examined and found correct, the expenditures being supported by proper vouchers. The balance of $4,616.04 is with the following Washington, D. C., banks:

American National Bank of Washington.	$459.76
American Security and Trust Co.	4,156.28
	$4,616.04

HERBERT A. GILL,
Auditor

By publications:		
Publishers SCIENCE	$15,630.35	
Volume 63–66, preliminary announcement, circulars and forms	4,393.90	$20,024.25
By expenses Philadelphia meeting:		
To secretaries of Sections, general secretary and secretary of council	901.50	
To badges, help and general expenses	308.06	1,209.56
By expenses of Pacific Division:		
To salary of assistant secretary	1,050.00	
To allowance for office expenses	600.00	
To allowance for extension of membership	550.00	2,200.00

By expenses of Washington office:		
To salary of permanent secretary	1,500.00	
To salary of assistant secretary	1,500.00	
To extra help	1,100.23	
To postage	1,308.00	
To office supplies	112.77	
To expressage, telephone and telegrams	47.81	5,568.81
By miscellaneous disbursements:		
To treasurer, life membership commutations	530.00	
To committee of One Hundred on Scientific Research	18.80	548.80
		$29,551.42
By balance to new account		$4,616.04
		$34,167.46

SCIENTIFIC NOTES AND NEWS

THE late Lady Kelvin has bequeathed to Glasgow University £5,000 for promoting research and the teaching of physical science in connection with the chair of natural philosophy, long held by Lord Kelvin. The decorations and medals conferred on Lord Kelvin are also given to the university.

THE British Chemical Society has decided to publish portraits of the three past presidents, Sir Henry Roscoe, Dr. Hugo Müller and Professor Raphael Meldola, who have died during the past year. The portraits will be suitable for framing or for binding with the *Journal*.

THE Paris Academy of Sciences has elected as corresponding members Professors Liapounof, of Petrograd, and C. J. de la Valleé Poussin, of Louvain.

THE Paris Academy of Medicine has elected as foreign associates Professor Hector Treub, of Amsterdam, and Sir Almroth Wright, of London.

DR. WILHELM BRANCA, professor of geology at Berlin, has been elected a member of the Academy of Sciences at Halle.

DR. GEORGE W. CRILE, professor of surgery at the Western Reserve University, received the honorary degree of doctor of letters from Wooster College on May 12.

DR. CHAS. G. WAGNER, superintendent of the State Hospital for the Insane at Binghamton, New York, was elected president of the American Medico-Psychological Association at the recent New Orleans meeting.

HAROLD WINTHROP BUCK, vice-president of the engineering firm of Viele, Blackwell & Buck, of New York City, has been elected president of the American Institute of Electrical Engineers.

SIR THOMAS H. HOLLAND, F.R.S., professor of geology in the University of Manchester, has been appointed chairman of a commission which the British government is forming to survey the economic resources and industrial possibilities of India.

DR. H. S. HALLOWAY, Boston, has been appointed state bacteriologist of Alabama.

W. F. HORTON, mining technologist of the bureau of mines, has resigned to accept a position with a steel company.

FREDERICK J. H. MERRILL, from 1899 until 1904 state geologist of New York, from 1905 until 1913 consulting geologist and mining engineer in Mexico, Arizona and California, and since 1913 field assistant of the California State Mining Bureau, has moved to Los Angeles, where he will resume consulting practise in geology and mining engineering.

J. D. THOMPSON, JR., assistant in geology at Cornell University, has accepted a position as geologist with an oil company in Oklahoma.

PROFESSOR A. S. HITCHCOCK, systematic agrostologist of the U. S. Department of Agriculture, will leave about May 28 for Honolulu to study and collect the grasses of the Hawaiian Islands. He will be accompanied by his son, Albert E. Hitchcock, as assistant.

MR. ARTHUR W. SAMPSON was at the New York College of Forestry, from May 10 to 12 inclusive, holding seminars and lecturing upon grazing in the national forests. Mr. Sampson is plant ecologist in the Forest Service and director of the Utah Forest Experiment Station in central Utah.

AT a meeting of the Washington Academy of Sciences on May 11, Dr. Erwin F. Smith, of the Bureau of Plant Industry, delivered an illustrated address on "Resemblances between Crown Gall in Plants and Human Cancer."

A public meeting of the District of Columbia Chapter of the Society of the Sigma Xi was held in the auditorium of the U. S. National Museum, on May 19, 1916. Mr. Frank N. Meyer, agricultural explorer for the U. S. Department of Agriculture, gave an illustrated lecture entitled "Travel and Exploration in China." About two hundred members and guests of the chapter were present. This was the first public lecture that has been given by the recently organized alumni chapter in Washington, D. C.

At the meeting of the New York Academy of Medicine, on May 4, Dr. Walter B. Cannon, George Higginson professor of physiology in the Harvard Medical School, delivered an address on "An Explanation of some Disorders supposed to have an Emotional Origin." The discussion was opened by Dr. Henry Rutgers Marshall.

Professor Frederic Slocum, of the department of astronomy of Wesleyan University, gave an address, on May 19, before the Brown Chapter of Sigma Xi at Brown University on "The Structure of the Sidereal Universe."

An appeal was made to the medical fraternity of Philadelphia at the College of Physicians, on May 5, to supply at once fifty physicians and surgeons for service in China. The appeal was made by Professor W. H. Welch, of the Johns Hopkins University, a member of the Chinese Medical Board and Dr. H. J. Howard, connected with the Canton, China, Hospital.

At the meeting of the Chemical Society, held at Burlington House on May 18, the last of the three lectures arranged for this session was delivered by Professor F. Gowland Hopkins, F.R.S., whose subject was: "Newer Standpoints in the Chemical Study of Nutrition."

The annual meeting of the British Iron and Steel Institute was held at the Institution of Civil Engineers on May 4 and 5. An inaugural address was delivered by the new president, Sir William Beardmore, and the Bessemer medal for 1916 was presented to Mr. F. W. Harbord.

In memory of the late Professor Charles Simeon Denison, whose death occurred three years ago, a bronze tablet has been placed in the arch of the engineering building of the University of Michigan, and the arch has been named the Denison Archway. Professor Denison was for forty-two years a member of the engineering faculty, and was the first to foster the idea of the construction of the Engineering Arch.

Elmer Lawrence Corthell, distinguished as a civil engineer, died at Albany on May 16, aged seventy-six years.

The twenty-first summer meeting and eighth colloquium of the American Mathematical Society will be held at Harvard University during the week beginning Monday, September 4, 1916. The first two days will be devoted to the regular sessions for the presentation of papers. The colloquium will open on Wednesday morning and close on Saturday morning. Courses of five lectures will be given by Professor G. C. Evans on "Topics from the Theory and Applications of Functionals, Including Integral Equations," and by Professor Oswald Veblen on "Analysis Situs."

The Secretary of State, on the recommendation of the superintendent of the United States Coast and Geodetic Survey, and the Secretary of Commerce, has recently appointed Mr. William Bowie, of the Coast and Geodetic Survey as the member from the United States of the Permanent Commission of the International Geodetic Association. Since 1909 Mr. Bowie has been chief of the Division of Geodesy of the United States Coast and Geodetic Survey, and in 1912 he was one of the delegates from the United States to the convention of the International Geodetic Association, which met in Hamburg, Germany. This association was organized more than fifty years ago for the purpose of securing the cooperation of the European nations in undertaking certain geodetic problems which were international in scope. In 1886 the association invited nations outside of Europe to join and three years later Congress gave the United States permission to become a contributing member. Previous to the present war twenty-

three nations of the world were represented in the association. One of the most important of the recent undertakings of the association is the maintenance of four observatories for the study of the variation of latitude. These observatories are located on the thirty-ninth parallel of latitude, in the United States, Italy, Turkestan and Japan. Ukiah, California, is the location of the observatory in this country.

THE *Bulletin* of the American Mathematical Society notes that on account of the war two mathematical periodicals have suspended publication, *L'Education Mathématique,* which concluded its sixteenth and last volume with the issue for July, 1914, and the *Revue de Mathématiques Spéciales,* last issued in September, 1914, in completion of its twenty-fourth consecutive year.

AT the eighty-seventh annual general meeting of the Zoological Society of London, according to the report in the London *Times,* the Duke of Bedford, who presided, said that during 1915 they had repaid the bankers £5,000 instead of the usual £2,000 and had invested over £4,000, chiefly in war loan. Thus in a full year of war they had improved the financial position of the society by £9,000. They had stopped all new work; they had postponed improvements in the gardens; they had refrained from making costly purchases; and they had greatly reduced expenditure on the library and scientific publications. But despite increased cost of provisions they had not allowed the animals to suffer in condition. The council had decided to keep up the flower gardens, believing that the bright presentment of the return of spring and promise of sunny summer days are legitimate distractions at this time. That the gardens had proved attractive in the past year was proved by the fact that for the fourth year in succession the number of visitors had been over a million. During the war the families of sailors and soldiers on active service were admitted free and on Sundays wounded men in uniform were also admitted free.

THE third meeting, for the year 1915–16, of the Pennsylvania Chapter of Sigma Xi was held in the Wistar Institute of Anatomy on Wednesday evening, March 29, 1916. Supper was served in one of the large laboratories on the third floor of the institute to ninety-five members. Afterwards Dr. Greenman presided and Dr. Allen J. Smith spoke on "Leprosy" in the Library on the second floor. Under the title of the "Rat in the Service of Biology," Dr. H. H. Donaldson reviewed the neurological investigations at the Wistar Institute for the last ten years, describing some of the advantages offered by the albino rat for biological studies. The members were then conducted on a tour of inspection of the institute. Special interest was manifested in the colony house, containing 5,000 rats, used in the experimental work.

THE Berlin Society of Social Hygiene, shortly after the beginning of the war, postponed indefinitely the awarding of the prizes ($200 and $100) for the best essays on "Influence of Social Betterment of Families on Eugenics." The society has decided to award the prizes on July 31, 1916.

ON Tuesday evening, April 11, Northwestern University celebrated the fiftieth anniversary of the founding of Dearborn Observatory. The observatory was founded by the citizens of Chicago in December, 1862, and within a month of the inception, the world's then greatest telescopic lens was purchased. In November, 1865, the group of contributors perfected the organization of the Chicago Astronomical Society, and on December 28 called Professor Truman H. Safford to the directorship. On his arrival the telescope was shipped, reaching Chicago on March 25; it was in place on April 11, 1866. On that evening the members of the society and guests assembled to make the first observation. Under Professor Safford's direction the work of the observatory went forward actively until the Great Chicago Fire of 1871 prostrated the city and robbed the observatory of its support. Professor Elias Colbert, who had been assistant director, later assumed active charge, and with the exception of a few months in 1876, when Professor S. W. Burnham was acting director, remained in charge until the appointment of Professor George W. Hough to the directorship on May

6, 1879. On August 10, 1887, a contract between the society and Northwestern University was made, and shortly thereafter the instruments were transferred to Evanston and placed in the observatory built through the gift of Mr. James B. Hobbs. Professor Hough actively conducted the observing until his death on January 1, 1909. The present director, Professor Philip Fox, was appointed September 1, 1909.

Professor E. J. Saunders, of the department of geology of the University of Washington, will conduct a geological field course in the Glacier and Yellowstone Parks from June 19 to July 28.

The plans for the coming season of the Harvard Field School of Physiography and General Geology provide for eight weeks of continuous field work in an unsurveyed portion of the Rocky Mountains. Camp will be established on the south slope of the San Juan Mountains of southwestern Colorado. Work will begin early in July and continue until the second of September. There will be accommodations for twenty-four students in the party. Two distinct units will be organized. Professor Wallace W. Atwood will have general charge of the work. Dr. W. P. Haynes will have immediate direction of the work of one unit, and Dr. F. H. Lahee of the other unit. During the first six weeks a systematic geological and geographical survey will be made of a portion of the range. This work will be conducted as nearly as possible along the lines approved by the U. S. Geological Survey. During the last two weeks the party will take a somewhat extended tour through the higher mountains, so as to study a wide range of phenomena, visit several of the mines and mills, and come to appreciate the larger problems in the geologic and physiographic history of the mountain area. Those wishing to join the party should apply to the director as soon as possible. Membership will probably be closed by the first of June.

The Naples Table Association for Promoting Laboratory Research by Women has held its annual meeting at Bryn Mawr College. It was voted to offer a prize of $1,000 for award in April, 1918, for the best thesis written by an American woman on a scientific subject embodying new observations and new conclusions based on independent laboratory research in biological (including psychological), chemical or physical science. Miss Virginia Gildersleeve, dean of Barnard College, was elected president for 1916–17; Mrs. Elizabeth L. Clarke, representing Smith College, treasurer; Mrs. Ada Wing Mead, of Providence, secretary for three years.

The estate of Addison Brown, for many years a United States District Judge, who died on April 9, 1913, has been appraised at $883,406. Judge Brown, who was an authority on the flora of the United States, left United States Steel stock valued at $21,775 to the New York Botanical Gardens for publications. He gave $10,000 to Harvard, of which $7,500 was to establish a scholarship for an undergraduate student, and $2,500 for a prize in the law school for an essay on maritime or private international law. Amherst College and Bradford Academy each received $5,000 for scholarships.

UNIVERSITY AND EDUCATIONAL NEWS

The fiftieth anniversary of the founding of Carleton College will be celebrated on October 12 and 13.

The curriculum of the college of mining of the University of California has been reshaped so that with the beginning of the sophomore year students will choose between mining engineering, metallurgy, economic geology, or petroleum engineering. A new four-year course in chemical engineering has been announced by the college of chemistry, of which Gilbert N. Lewis is the dean.

Col. John Biddle, engineer officer, U. S. A., at Baltimore, has been appointed superintendent at West Point to succeed Col. Clarence P. Townsend on July 1.

Mrs. Aurelia Henry Reinhardt has been elected president of Mills College, California.

At the New Mexico College and Station, Dr. E. P. Humbert has resigned as dean of agriculture and agronomist to become plant

breeder in cotton investigations at the Texas Station, and has been succeeded by Rupert L. Stewart.

DR. F. J. E. WOODBRIDGE, Johnsonian professor of philosophy in Columbia University and dean of the graduate faculties, has been appointed lecturer in philosophy on the Mills Foundation in the University of California, from January 31 to June 30, 1917.

DR. WILLIAM F. ALLEN, instructor in anatomy, University of Minnesota, has accepted a position as professor of anatomy in the medical department of the University of Oregon.

DR. ALFRED L. GRAY, professor of physiology in the University of Virginia, has been transferred to the chair of roentgenology and has been succeeded by Dr. Charles H. Lewis.

PROFESSOR W. H. TWENHOFEL, of the University of Kansas, has been appointed associate professor of geology at the University of Wisconsin, to succeed Professor Eliot Blackwelder.

FRANK H. PROBERT, a graduate of the Royal School of Mines, London, and for the past twenty years engaged in consulting mining engineering practise, has been appointed professor of mining in the University of California, as successor to the late Professor Samuel Benedict Christy.

DR. JEAN FELIX PICCARD, of the University of Lausanne, Switzerland, has accepted an invitation of the University of Chicago to spend next year at the university as assistant professor of organic chemistry. Dr. Piccard, who has worked with Professor Willstaetter and been research assistant of Professor v. Baeyer, will devote himself exclusively to graduate work and to directing research in organic chemistry.

DISCUSSION AND CORRESPONDENCE

CONSERVATIO VIRIUM VIVARUM

TO THE EDITOR OF SCIENCE: The term energy was introduced by Thomas Young in 1807 to denote MV^2, or twice what is now known as kinetic energy. Rankine extended its use to cover potential and total energy. But though the name was new the concept was not. This was known long before under the term facultas agendi, which is in some respects more appropriate, for if our word energy is to be translated into Greek it must be rendered δύναμις not ενέργεια.

The following extract from an old paper contains a part of the early history of the idea of energy.[1]

There seems to be a general impression that the natural philosophers of the last century, when they used the quantities now known as kinetic, potential and total energy at all, regarded them from a purely algebraical or geometrical point of view, failing to perceive their great physical significance. In this respect these physicists seem to have been underrated: as some passages from the first John Bernoulli, Euler's teacher and D. Bernoulli's father, will show. In a paper on the true conception of living forces[2] he generalizes the idea of vis viva and defines it as equivalent to capacity for doing work, or *facultas agendi*, which is simply a Latin equivalent of the Greek energy [as Young understood it]. In Section I. of this paper he says (translated):

> Vis viva does not consist in the actual exertion, but in the capacity for doing work; for it subsists even when it does no work nor has any object whereon it could act; so for example a strained spring, or again a body in motion, has in itself the capacity of doing work, so that if nothing external to itself comes in its way upon which it may exert itself, and so long as there is no object present with which it can come in contact, it infallibly retains it all undiminished by time, and does not do the work which it would be capable of doing if it had the opportunity.

This seems a clear and even a vivid statement of the law:

> When a system is subjected to no external forces, its energy remains constant.

In Section III. he takes a further step.

> Vis viva (which would be more aptly named facultas agendi, gallicé le pouvoir)[3] is something real

[1] *Amer. Jour. Sci.*, Vol. 45, 1893, p. 97. See also *idem.*, Vol. 46, 1893, p. 151.

[2] "De vera notione virium vivarum," *Acta Eruditorium*, Leipzig, 1735, p. 210.

[3] The term power is now rarely used for energy, but it is scarcely a generation since this meaning was common enough. Saint-Venant (*op. cit.*, p.

and substantial, which has an independent existence and, whatever it consists of, depends upon nothing else. Whence we conclude, that any given vis viva is of determinate quantity of which none can disappear except it reappear in the effect produced. Hence it follows at once, that vis viva is always preserved, and so perfectly that what inhered in one or many bodies before action is now, after action, necessarily found in another or in several others excepting what remained in the first system. And this we call the *conservationem* virium vivarum.

Compare this with the modern statement: In any system the variation of energy is equal to the external work done by the system less the work done by external forces upon the system.

John Bernoulli was under no misapprehension as to the importance of the principles he had stated. He says in substance: Whether bodies are regarded as communicating motion to one another or whether one considers the various modifications of the motion of one and the same body depending on its own force (where nothing can vanish without an equivalent effect), "pro fundamento et principio universali poni debet conservatio virium vivarum, hoc est illius *facultatis agendi*."

George F. Becker

SERPENT DREAD IN THE PRIMATE FAMILY

Apropos of the discussion which has been appearing in Science relative to fear of snakes, I am impelled to observe how unfamiliar some writers on an evolutionary topic appear to be with what Darwin, himself, the fountain head of evolution, may have had to say on the subject.

Darwin, in his "Descent of Man," second edition, Appleton, 1892, page 72, calls attention to this primal instinct in man and monkeys, and gives an account of how his experiments with monkeys in the zoological gardens confirmed the previous experiments of Brehm, in establishing its presence in the whole primate family.

While not agreeing with Mr. Dabney in his conclusions that India is pointed to as the place where a snake-fearing creature would most likely originate because of the abundance of poisonous snakes there (serpents of the constrictor class would be even more of a menace to those "long tailed, pointed eared ancestors" of ours if Huxley's further deduction be accepted that "they were probably arboreal in their habits"), it seems to me that the evidence is overwhelming in favor of "serpent dread" being a vestigial instinct—exceptions to its presence in persons like Mr. McClellan to the contrary notwithstanding.

In my own case, though for years a teacher of zoology, and accustomed to the handling of snakes, I confess to never having been able to entirely overcome a certain shuddering dread of them, and am convinced that my repugnance is not due to early teaching on the subject. I am sure that this is the normal attitude of the members of the human family, and the rest of the primates as well, toward snakes.

That very young children may not have as yet developed in them this fear is no argument against its being an inherited instinct.

There are many such instincts that do not appear until the period in life when the exercise of them would operate most strongly for the protection of the species.

It is a well-known fact that the young of the primates are quite helpless for a relatively long period, and during this stage of their existence are carried about and cared for exclusively by the mother. There would ordinarily be no protective service performed by the exercise of "serpent dread" in the young during this period.

Nor is it a matter of much weight against the instinctive character of the fear that it is not always very discriminating zoologically. It is enough that there is some suggestive resemblance or association in the object which arouses it.

A shadow made by an old hat shied over a flock of young chickens will be just as effective in sending them scurrying to cover, as that of the hawk itself, and will evoke from the mother hen just as surely the characteristic warning cry. Also a crooked stick met with

785) in 1864 defined the potential of one or more forces as "leur pouvoir moteur total." B. Peirce in his great work on analytical mechanics, 1865, always uses "power" instead of "energy."

in the woodland path, or a rustle in the dry grass beside it, will startle a person fully as much as the sight of the snake itself seen a short time before.

As very strong evidence in favor of the universality of the serpent dread instinct is the solution it affords to the familiar serpent nature-myth in Genesis. Scholars are pretty well agreed that the true interpretation of primitive legends lies in the attempts of primitive peoples by them to explain the origin of fundamental institutions, universal customs, innate impulses.

As Gunkle in his "Legends of Genesis" observes:

> They [the legends] are attempts to answer such questions as, Whence came the heavens and the earth? Whence the language of man? Why the love of the sexes? Why does the serpent go on his belly, and why does the "seed of woman" continue so relentlessly to "bruise its head"?

Such a legend speaks eloquently of the universality in the human family of the fear and hatred of snakes, and of the instinctive character of these emotions.

ARTHUR M. MILLER

LEXINGTON, KY.

TO THE EDITOR OF SCIENCE: The disputants regarding our instinctive fear of snakes may "all be right and all be wrong." It is not necessary that the whole human race should have the same instinct. The feeling of repulsion for snakes and worms, and that for many-legged things such as spiders and centipedes, are rarely felt by the same person. I have the latter to an uncontrollable degree, and I do not believe that I learned it from any one. I can not remember that either of my parents felt about spiders as I do. I do not feel about snakes and worms in the same way at all. It is therefore possible that one person may have a congenital repulsion for snakes and that another may have been free from such a repulsion from childhood.

As for establishing a connection between such facts and "the cradle of the human race," I leave that to the mythical philologist who derived Middletown from Moses "by dropping the 'oses' and adding 'iddletown.'"

ARTHUR E. BOSTWICK

SCIENTIFIC BOOKS

Laboratory Manual for the Detection of Poisons and Powerful Drugs. By WILHELM AUTENRIETH. Translated by WILLIAM H. WARREN. Second American edition from the Fourth German edition. 8°. P. Blakiston's Son and Co., Philadelphia, 1915. Pp. xv + 320; Figs. 25. $2.00.

The fourth German edition of this well-known laboratory text-book has been sufficiently revised, enlarged and extended in scope to warrant the term "manual" as it appears upon the title page. Former editions were so incomplete in every subject covered as to lead the reader to wonder whether the title was not a misleading one.

In this last edition the author has presented his subject in the same order, chapter by chapter, as in former editions. The book being strictly a laboratory guide, the chapters dealing with the various noxious substances discussed, have naturally been arranged with reference to the sequence of steps taken by the chemist in his search for the presence of a poison.

Chapter I. treats of poisons which may be volatilized in a current of steam and thus separated from organic material. Chapter II. discusses the Stas-Otto method for the extraction of vegetable poisons and powerful drugs and describes the special reactions by which these substances may be identified. Chapter III. treats of the inorganic (metallic) poisons. Chapter IV. discusses corrosives, several poisonous anhydrides of organic acids; a number of powerful synthetic drugs; toxalbumins and matters of importance to physician and analyst. Under Chapter V. are grouped a selection of special methods for the qualitative detection and quantitative determination of arsenic, phosphorus, a number of important alkaloids, and salicylic acid. In this chapter is also given a brief outline of Mauch's very ingenious chloral hydrate method for the separation and identification of the active principles of plants. Chapter VI. is devoted to crude drug assay and evaluation according to the official methods of the German pharmacopœia. Chapter VII. discusses the forensic chemistry of blood and blood stains.

The translator has admirably performed his task and has placed in the hands of American students a book almost unique in its field in the English language. The text is exceptionally free from the peculiarities of Teutonic sentence construction usually met with in translations of German works. The additions made by Dr. Warren to the new American edition greatly enhance the usefulness of the book as a student text. It is to be regretted that in his additions to the chapter dealing with the identification of human blood he did not include the recent American advances in the study of "blood crystals" (Reichert and Brown) which to the chemist are more important than agglutination tests, and that he did not feel warranted in inserting in Chapter VI. some of the official methods of drug assay according to the U. S. Pharmacopœia. Doubtless many other teachers in common with the reviewer, using this book as a laboratory text with their students, believe that, although the primary object in work of this nature is to afford instruction in manipulation and chemical reactions, if this can be accomplished by the use of official methods it is wiser to employ such processes than those which the student may not use in his future work. It would not have added materially to the size of the book to have introduced notes pointing out the divergence of U. S. P. methods (if any) from those given by Autenrieth.

A matter of surprise is that the space devoted to poisoning by phosphorus has been increased, although statistical information leads to the conclusion that cases of phosphorus poisoning have greatly decreased since the manufacture of the yellow phosphorus match has been forbidden by statutory enactments. Obviously no small laboratory manual can be complete, yet it is a matter of disappointment that such very important drugs as the morphine derivatives such as heroin, peronin, etc., have received no mention, nor have the cocaine substitutes, eucaine, novocaine, etc. In view of the stringent American antinarcotic laws and the nation-wide campaign to stamp out habit-forming drugs, it is difficult to understand why such manifestly important matter should have been omitted by the translator.

In spite of the small size of the book, Dr. Autenrieth has succeeded in incorporating between the covers a surprising amount of information and suggestions. This has been accomplished by the free use of fine type and by making all descriptions of tests and methods as brief as possible. This attempt to carry conciseness of statement to the limit is one of the only serious faults so far as the actual material presented is concerned, for the reviewer has found that his students experience great difficulty in properly performing many of the tests described.

Taken all in all the tests selected have been well chosen and with one or two exceptions the directions given are correct and down to date. The book can be heartily recommended to all who are interested in the usual problems of forensic chemistry and should prove a welcome addition to the book shelf of every analytical chemist and pharmacist. Not the least interesting sections will be found to be those giving a brief summary of our present knowledge of the action of poisons and the changes they undergo during their elimination.

E. M. Chamot

The Chemistry of Colloids. By W. W. Taylor. London, Edward Arnold. 328 pp. 7/6 net.

This is the first attempt at an original textbook in English dealing with the important subject of colloidal chemistry. The author is a lecturer in chemistry at the University of Edinburgh, and the book owes its birth, as is the case of many scientific books, to a series of lectures given by the author before a class of advanced students. Viewed in this light, the book will undoubtedly prove useful, not only to the student, for whom it will save laborious note-taking; but also to the instructor, who will benefit by the mass of arranged facts which the book offers.

The principal portions of colloidal chemistry are treated in a manner which is not only brief but sometimes approaches laconicism. The general properties of colloids are followed with a discussion of the van Weimarn theories of amorphous substances which naturally lead to a description of the usual methods for preparing colloidal solutions. The theoretical side of

colloidal chemistry, *i. e.*, the questions of surface tension, adsorption, etc., which are of such fundamental importance to the whole subject, are first discussed toward the end of the book. In the opinion of the reviewer this is an unfortunate arrangement, for to take one example, a treatment of the coagulation of colloidal solutions without a knowledge of the adsorption laws, must necessarily be handicapped to say the least.

For the professional worker in the field of colloidal chemistry, the book has little to offer, first because of its brevity and second because of the fact that although dated January, 1915, many of the results of recent research are not to be found in the book.

However if one is interested in obtaining a statement of the principal facts of colloidal chemistry unencumbered with too much theory, the book is to be recommended.

WALTER A. PATRICK

Handbook of Colloidal Chemistry. By Wo. OSTWALD. Translated by M. H. FISCHER. 278 pp. Blakiston's Son & Co. $3.00 net.

The above book is a translation of the third German edition of Wo. Ostwald's "Grundriss der Kolloidchemie." Wo. Ostwald's name has been so intimately associated with the development of colloidal chemistry, that it needs no introduction even to American readers. His broad general knowledge of his subject reminds one very forcibly of the attitude of his father, Wilhelm Ostwald, toward physical chemistry. Following the footsteps of his father, the son also endeavored to write an authoritative text-book in his own chosen field. The above book is the result, and while the reviewer can not agree with the translator in saying that Wo. Ostwald in colloidal chemistry occupies a position analogous to Wilhelm Ostwald in physical chemistry, or J. Liebig in agricultural chemistry, nevertheless one must agree that his text-book is most stimulating and interesting.

The book is divided into two parts, a general and special study of colloidal chemistry. The first part is devoted largely to classification and systematics, being the particular field in which Ostwald excels. The treatment is very general, indeed in many cases it seems as if the spirit of generalization was carried too far. This is well illustrated in Ostwald's "negative" surface tension, the existence of which is not supported by experimental evidence and which would indeed be contradictory to our fundamental ideas of surface tension.

The second part of the book dealing with the properties of colloidal solutions is the most interesting. This is especially true of that portion which treats of the viscosity of colloidal solutions.

The book is made very attractive with its abundant photographs and tables. On the whole the translation is acceptable, but the frequent use of the ugly word "dispersion-means" in the place of dispersion medium strikes one as inexcusable.

WALTER A. PATRICK

The House Fly, Musca domestica Linn., its Structure, Habits, Development, Relation to Disease and Control. By C. GORDON HEWITT. Cambridge: University Press.

The house fly has been an illustration of the fact that it is concerning the most common animals that we often know the least. Though associated with man through all ages, and doing him incalculable injury, this insect, until recently, was either viewed with complete indifference or rather with favor as a paragon of industry. To any one who desires to see how all of this has been changed and how fully the menace which the house fly forms to public health has been established, the book by Dr. Hewitt is highly recommended. It is not a popular treatise in the usual sense but, as the author states in the preface, it complements the work by Dr. L. O. Howard, "The House Fly: Disease Carrier." Although primarily intended for entomologists, sanitarians and physicians, it contains much matter of general interest.

The various parts of the book deal with the structure and habits of the house fly, its breeding habits, natural enemies, various related species frequenting houses, relation to disease and control. The strongest parts of the book appear to be those dealing with the anatomy and with the dissemination of dis-

eases. The author's work on the anatomy of the house fly began at the University of Manchester in 1905. A very satisfactory monograph which he published in 1907–8 is largely incorporated in the present work. On the subject of the muscular structure of the larvæ particularly, the contribution Dr. Hewitt makes is important. Previous writers generally have passed over this subject lightly. In fact the anatomy of the larvæ of insects has received but little attention. The principal previous work referred to the larva of the goat moth and was published in 1762. There are few investigators qualified to do such work on anatomy as has been done by Dr. Hewitt. His account not only widens our knowledge of insect structure, but corrects many errors which have been made by less competent observers.

The subject of the rôle of the house fly in the dissemination of disease is an extremely complicated one. It is not sufficient to determine the presence of pathogenic bacteria on the fly. Immediately questions of the viability of the bacteria and the habits of the fly must be considered before the actual importance of the insect in disseminating the germs can be considered settled. On this subject in the last few years masses of articles of the most diverse kinds have appeared. Dr. Hewitt analyzes the evidence and treats it in a conservative and judicial manner. His conclusions will undoubtedly be fully substantiated in the course of time. Even since the book was published much corroborative evidence has been supplied.

The book is written in a clear and effective style, is well balanced, well illustrated and altogether in keeping with the high reputation which the author enjoys.

W. D. Hunter

CONTRIBUTIONS TO MINERALOGY AND THE MINERAL SPRINGS OF JAPAN

The Japanese publication *Beiträge zur Mineralogie von Japan*, so ably conducted by Professor Tsunashirô Wada, offers in its fifth number, recently issued, several valuable contributions to the mineralogy of the Japanese empire. Although the title of this publication is in German, all of the articles, with the exception of some in the first number, have been written in English.[1]

Of especial interest is the first paper, by Nobuyo Fukuchi, "The Minerals of Chôsen (Korea)." It presents a summary of about sixty mineral species that have so far been discovered in Korea, among them the following precious stone materials, although hardly of gem-quality: garnet, beryl (?), tourmaline and zircon, as well as rock crystal, smoky quartz, amethyst, rose quartz, etc. Large quartz crystals, of a peculiar reddish hue due to inclusions, have been found at Hukuganzan, Keishô-nando, as have also amethyst crystals. Smoky quartz occurs at several places near Keishû, Keishô-hokudô, and in this region are rock crystals affording good material for lenses. Gold placers and gold veins occur at several places; one large nugget weighing about 915 grams (nearly 30 ounces) was found near Tansen and is noted in the *Journal* of the Geographical Society of Tokyo for 1912. Limonite, the chief iron ore of Korea, occurs in four places: The Kaisen iron mine in Heïan-hokudô; and the Inritsu, Sainei, and Kenjiho mines in Kokai-dô. Garnet has been found in the Suian gold mines in Kokai-dô and in the Inzan gold mines in Heïan-hokudô; columnar crystals of zircon occur in a graphite deposit at Jidô, Heïan-hokudô; and black tourmaline is found near the Sakushû gold mines, Heïan-hokudô, and at two other localities. The occurrence of graphite in the Gneiss system and the Korean system or in old Paleozoic sediments in Korea is also studied by Nobuyo Fukuchi. The graphite veins frequently consist of two symmetrical halves of similar structure with a boundary line between them, and graphite deposits of this type are of great purity and particularly valuable from an economic standpoint. The veins are believed to owe their formation to dissociation from neighboring graphite nests, caused

[1] *Beiträge zur Mineralogie von Japan*, ed. by T. Wada, No. 5, November, Tokyo, 1915; 101 pp., plate; pp. 207–305 of continuous pagination.

by the heat of the granite magma or by emanation gases.

Other papers are: "A Monoclinic Prismatic Sulphur from Reisuiko in Taiwan," by Masakichi Suzuki; "Studies on some Minerals of Japan," by Mikio Kawamura, giving a thorough exposition of the optical properties of danburite from Obira, Province of Bungo; "Epidote Crystals from Katakai in Sasaharamura, Province of Iwaki," by Kinzô Nakashima; "Ferberite from Kurasawa in the Province of Kai; and Hübnerite from Nishizawa in the Province of Shimo-tsuke," by Kotora Jimbô.

The description of two aragonite cones from a liparite region in the gold district of Kuriyama, by Watanabe (pp. 237–241, plate), illustrates two interesting examples of these cone formations at the outlet of geysers. One of these Kuriyama geysers emitted 4.26 liters of colorless hot water per minute, the temperature being 94° C.; about 44 grams of carbonate of lime are deposited in twenty-four hours, something like 4½ per cent. of the amount in the water. The cones are blunt-ended, and composed essentially of lime carbonate with a trifling admixture of sulphur. An interesting fact is the calcite structure of the inner or older part of these cones, in contrast with the very minute hexagonal columns of aragonite terminated by the basal pinacoid, forming the loose inner part of the lower portion of the cone. One of these specimens (Plate X., Fig. 1) was formed between August 26, 1907, and June 25, 1908; it is 30 cm. high, the diameter at base being the same; its weight is 13.878 kg.; the canal is not strictly vertical, but rather oblique. The second example (Fig. 2) has two canals, its dimensions being: height, 24 cm.; diameter at base 30 cm. According to local tradition a cone about 1½ meters high once stood at the same spot.

The precious opal of Hôsaka is briefly noted by Yônosuke Ôtsuki (pp. 274, 275). The locality lies in the upper course of the rivulet Kikôzugawa, which flows between the village of Hôkawa and the mountain-pass Kurumatôge. The opals are found within nodules (silicified spherulites) enclosed in a green-black pearlite which turns gray in weathering. The nodules are usually from 3 to 5 cm. in diameter, although some measure as much as 18 cm. across; they are brownish or black, resembling potatoes in shape, good opals coming more frequently from the brown than from the black nodules. The opal-material is here present in great variety: milk opal, opal-agate, precious opal, glass opal, as well as the smoky, obsidian-like variety, the yellowish-green, the waxy and others. Important is the granulated appearance of some specimens when viewed in a particular direction, the granules offering one interference color by incident light, while the cement assumes a different color. The specific gravity of the precious opal is 2.22, its hardness 5.5 and its aqueous content 8.49 per cent.

Crystals closely resembling the jarrowite from the Clyde-Estuary in Scotland have been found in Chinano province, Japan; to these have been given the name, *gennô-ishi*, or hammerstone.[2] Both are judged to be pseudo-gaylussite, or calcite after gaylussite, the peculiar shape having led anthropologists to designate such crystals "stone-axe." The *gennô-ishi* crystals of Shinano province are acute pyramidal or prismatic with very rough, curved surfaces. There are deep parallel striations on the crystal faces, perhaps sutures of oscillating combination, and also many small sub-crystal protuberances, placed in parallel order; it seems that sometimes a crystal was formed by an aggregation of many of these parallel individuals.

In color the Clyde crystals differ somewhat from the Japanese, the former being deep brown with resinous luster and the latter light brown with a like luster. A comparison of the chemical composition is given by the following analyses, there being a considerable undetermined residue in the case of the Shinano crystals and in Clyde No. I., which may represent organic matter.

[2] Tadusu Hiki, "On the Genô-ishi"; reprint from the Memoirs of the College of Engineering, Kyôto Imperial University, Vol. I., No. 2, Kyôto, 1915; plate.

	Shinano	Clyde	
		I	II
SiO_2	0.64	0.12	.....
Fe_2O_3	3.44	5.36	.....
Al_2O_3	1.00	0.12	.....
CaO	52.33	46.60	47.63
MgO	0.48	4.94	4.21
CO_2	37.00	36.40	39.91
P_2O_5	.....	.....	2.23
Organic matter	.....	.....	5.94
	94.89	93.54	100.22[3]

An exceedingly comprehensive work on the mineral springs of Japan has just been published by Dr. R. Ishizu, expert of the Imperial Hygienic Laboratory at Tokyo.[4] No less than 1,201 of these springs are tabulated, and a very large number of analyses are given, as well as tables of the radioactive springs of Japan, and of the leading European springs of this interesting class. Part III. offers notes on prominent spas and resorts. The numerous plates illustrate the scenic beauties of the various localities.

George F. Kunz

SPECIAL ARTICLES

ANTAGONISTIC ELECTROLYTE EFFECTS IN PHYSICAL AND BIOLOGICAL SYSTEMS[1]

The purpose of this paper is to summarize briefly certain experiments regarding the influence exerted by antagonistic electrolytes on emulsions and other physical systems, and to compare the data in question with those available regarding the influence exerted by the same antagonistic electrolytes on living cells, in an attempt to throw some light on the physical structure of protoplasm and the mechanism of certain vital processes.

In spite of the accumulation by Jacques Loeb, and other biologists, of a large amount of accurate experimental data regarding the effects exerted by electrolytes, singly and in combination, on living cells, there is, at present, no generally accepted physical explanation for the antagonistic or compensatory effects exerted by electrolytes on one another in biological systems.

In a preliminary communication published in 1913 based on certain physical and biological experiments, details regarding which will be found in a subsequent section of this paper, it was concluded that, with certain exceptions to be considered later, electrolytes may be divided, as regards their effect on the protoplasmic membrane, into two main antagonistic groups according to whether, like $CaCl_2$, they possess a more readily adsorbed or reactive cation, or, like NaOH, NaCl, etc., a more readily adsorbed or reactive anion. Substances of the former class appear to diminish the permeability of the membrane to water, while those of the latter class increase the permeability of the membrane. As will be seen later, the ratios in which antagonistic electrolytes counterbalance one another in biological systems correspond so closely with the ratios in which they balance one another in physical systems as to suggest the probability that balanced electrolyte solutions, like sea-water and the blood of mammals, are those in which the proportions of cations and anions adsorbed on or reacting with the protoplasmic membrane are equal, or at least compensatory, with the result that the colloidal equilibrium, and consequently the permeability of the membrane, remains unchanged. A somewhat similar conclusion was reached by Osterhout as a result of experiments on the electric conductivity of laminaria tissues. Under comparable experimental conditions the tissues which had been exposed to sea-water exhibited a practically constant resistance to the passage of an electric current, but, after exposure to solutions of

[3] The summation is .30 in error, which exists in the manuscript.

[4] "The Mineral Springs of Japan," with tables of analyses, radioactivity, notes on prominent spas and list of seaside resorts and summer retreats, specially edited for the Panama-Pacific International exposition, by Dr. R. Ishizu, expert of the Imperial Hygienic Laboratory, Tokyo Imperial Hygienic Laboratory, 1915, x + 94 + 203 + 70 + 8 pp., maps and illust., and 76 plates, folio.

[1] A summary of a paper read before the Biological-Chemical Society, Boston, Mass., December 28, 1915. Received for publication December 29, 1916. Publication delayed on account of necessity of condensation within suitable dimensions for this journal. (From the Biological-Chemical Laboratory of the State Institute for the Study of Malignant Disease, Buffalo, N. Y.)

NaCl, a markedly decreased resistance, and after exposure to solutions of $CaCl_2$, a markedly increased resistance, at least for a short period; but there was no appreciable variation from the normal after exposure of the tissues to mixtures containing NaCl and $CaCl_2$ in the ratios of 100 molecules of the former to one or two of the latter. Osterhout concluded as a result of these and other experiments that electrolytes may be divided into two main antagonistic groups according to whether they raise or lower the permeability of the protoplasmic membrane.

The ratio of 100 molecules of NaCl to 1 or 2 molecules of $CaCl_2$ is one of peculiar significance in biology. NaCl and $CaCl_2$ occur in approximately this ratio in sea-water, the blood of mammals, and other saline media capable of supporting life. Furthermore, marine organisms are killed by transference to artificially prepared solutions of NaCl or $CaCl_2$ isosmotic with sea-water, but they remain uninjured if transferred to a solution of NaCl to which enough $CaCl_2$ has been added to give the ratios in question.

The writer's experiments on emulsions start from an observation made by Bancroft that soaps of Na, used as emulsifying agents for oil and water, give an emulsion consisting of drops of oil dispersed in water like cream, while soaps of Ca exert the reverse effect, producing emulsions consisting of drops of water dispersed in oil like butter. The writer believed that these experiments might offer a physical explanation for the antagonistic effects exerted by salts of Na and Ca on one another, not only in biological systems of the type described above, but also in such purely physical processes as blood coagulation and the production of a casein clot. In the coagulation processes in question the transformation of a suspension of a protein dispersed in water, into a clot in which water is more or less dispersed in an outer or continuous protein phase is promoted by salts of Ca and inhibited or retarded by alkalies and salts of Na. Therefore the first question to determine was whether a similar transformation could be effected in the case of emulsions. In the preliminary paper referred to above the writer was able to demonstrate that suitably constituted emulsions of oil dispersed in water could be converted into emulsions of water dispersed in oil by shaking with salts of Ca, and that the transformation in question could be prevented, or a reverse transformation effected, by shaking with an adequate proportion of NaOH. It was subsequently demonstrated that NaCl, and other salts of Na, exert an effect on emulsion systems similar to that of NaOH but considerably weaker. The processes of blood coagulation and emulsion transformation appear to be similar physical effects promoted by salts of Ca and inhibited by alkalies and salts of Na. In both cases, a system consisting of a non-aqueous phase dispersed in water is converted, more or less perfectly, into a system consisting of water dispersed in the non-aqueous phase, analogous to the transformation of islands surrounded by water into lakes surrounded by land. It is obvious that a system of islands surrounded by water is freely permeable to water and water-borne substances, while a system of lakes surrounded by land is absolutely impermeable. A variety of intermediate systems exhibiting any desired degree of permeability can well be conceived. Since salts of Ca promote a transformation in one direction and alkalies and salts of Na in the reverse direction, it appears probable that by simply varying the proportions of the salts in question introduced into a given system it should be possible to vary the permeability of the system to water to any desired extent. Since variations in the permeability of protoplasm induced by variations in the proportions of salts of Ca and Na appear from Osterhout's experiments to account for the destructive effects exerted by salts of Ca and Na when used individually, and the protective effect exhibited when these substances are used jointly in ratios of 100 molecules of NaCl to 1 or 2 of $CaCl_2$, the question arises how far can such a mechanism as that described above in the case of emulsions and blood coagulation explain protoplasmic structure and function?

From what we know of protoplasm and the protoplasmic film it is by no means incon-

ceivable that the former approximates to a dispersion of proteins, fats, lipoids, and other colloids in water, while the latter approximates to the reverse type of system in which water is more or less dispersed in an outer or continuous phase of fats, lipoids, and possibly proteins. Arguments in support of the view that protoplasm when first formed is a system relatively freely permeable to water because water is the outer or continuous phase are, first, the active Brownian movement exhibited by protoplasm when inspected by means of the ultra microscope; and, second, the freedom with which water-soluble substances, artificially introduced through the protoplasmic film, permeate the protoplasmic material. Arguments in support of the view that the protoplasmic film is relatively impermeable to water, because water is more or less dispersed in an external or continuous phase, consisting at least in part of fats and lipoids, are, first, the resistance offered by the protoplasmic film to the passage of salts, sugars, and other water-soluble substances; second, the resistance to the passage of an electric current; third, the phenomenon of osmotic pressure; fourth, the variations in the proportions of given electrolytes within and without the cell; and, fifth, the freedom with which anesthetics and other fat solvents penetrate the protoplasmic system. Since the variations in permeability of protoplasm under the influence of salts of Ca and Na may well be attributable to a reversal of phase relations analogous to that observed in the case of emulsions, sols and jellies, the next question to determine is whether given electrolytes exert antagonistic effects on physical systems in the same ratios as on living cells. Before describing the experiments, it is necessary to refer briefly to the explanation offered by Bancroft for the apparently antagonistic action of soaps of Na and Ca in emulsion systems. Pure oil and water when shaken together do not give a permanent emulsion. Soap or some other so-called emulsifying agent must be employed. The emulsifying agent exerts its effect by concentration at the interface between oil and water, forming a film which prevents the subsequent coalescence of the dispersed particles. Bancroft concluded that soaps of Na, which are freely dispersed in water but not in oil, form a film which is wetted more readily by water than by oil, with consequently a lower surface tension on the water than on the oil side, and, since the area of the inside face of a film surrounding a sphere is smaller than that of the outside face, the film will tend to curve in such a manner as to enclose globules of oil in water, thus reducing the area of the side of higher surface tension to a minimum as compared with that of lower surface tension. Conversely, a film composed of Ca soap, which is freely dispersed in oil but not in water, is wetted more readily by the oil than by the water, the surface tension is lower on the oil than on the water side, and the film tends to curve in such a manner as to enclose the globules of water in an outer or continuous oil phase.

While studying reversible emulsion systems, the writer observed that when those electrolytes, like $CaCl_2$, that promote the formation of an emulsion of water in oil are present in such proportion as to balance those, like NaOH or NaCl, that promote the formation of an emulsion of oil in water, a critical point is recognizable at which neither type of emulsion predominates, and the oil and water separate rapidly under the influence of gravity into two layers. This observation affords a strong support of Bancroft's conclusion. Since the electrolytes in question are exerting an exactly compensatory effect on the film it has no tendency to curve in either direction, and, since it remains straight, neither phase is capable of surrounding the other. The mixture shaken together really contains two continuous phases analogous to the fiber and air in a sponge, and, since oil and water are both fluids, they separate readily under the influence of gravity.

Salts of divalent and trivalent cations, and, under certain circumstances, small amounts of acids appear to function in the same way as salts of Ca, promoting the formation of emulsions of water in oil. Alkalies, salts of monovalent cations, and of di- and trivalent anions, appear to function similarly to NaOH, promoting the formation of emulsions of oil in

water. Studies carried out by means of emulsions of oil and water are altogether too crude to determine the exact ratios in which antagonistic electrolytes exert compensatory effects. After experimenting with various procedures the following method was finally adopted. Aqueous solutions containing NaOH or Na oleate were allowed to run from a Traube stalagmometer or capillary pipette through olive oil containing a certain amount of fatty acid. If solutions of suitable strength were employed, surface films of soap were produced at the interface between oil and water, when the aqueous solution flowed out of the orifice of the pipette and came in contact with the surrounding oil. The size of an individual drop formed, and, since the volume is constant, its inverse the number of drops, depended upon the concentration of the NaOH employed. A *M*/1,000 NaOH solution gave from 40 to 45 drops, while one of half this strength gave from 20 to 25 drops, and one of double the strength gave several hundred drops or ran through the oil in a stream without the formation of any drops whatever. If NaCl was added to a given system of this type, the number of drops was rapidly increased, as will be seen from the accompanying table. If $CaCl_2$ was added to such a system the number of drops was diminished, but when NaCl and $CaCl_2$ were employed together they appeared to exert a compensatory effect upon one another in the proportions of 100 molecules of NaCl to one or two molecules of $CaCl_2$, according to the concentration of the solution employed. (See table.)

TABLE

Exper. No.	Concentration of			No. of Drops	Mol. Ratio NaCl : $CaCl_2$
	NaOH	NaCl	$CaCl_2$		
1	.001M	—	—	44	
2	.001M	.15M	—	300	
3	.001M	—	.0015M	24	
4	.001M	.15M	.0015M	44	100 : 1
5	.001M	.3M	.003M	43	100 : 1
6	.001M	.45M	.005M	43	100 : 1.1
7	.001M	.6M	.01M	43	100 : 1.6

To avoid any possibility of confusion, or any idea that this antagonism between $CaCl_2$ and NaCl is due to an antagonism between Ca and Na, the writer wishes to emphasize particularly the fact that these antagonistic effects are always attributable to a balance between cations, on the one hand, and anions, on the other, adsorbed on or reacting with a surface film or membrane. It simply happens that, in the case of $CaCl_2$, the cation Ca is far more readily adsorbed than the anion Cl, while, in the case of NaCl, the anion Cl is somewhat more readily adsorbed than the cation Na. The effect obtained from each individual salt is a resultant of the relative adsorption of cation and anion; and the effect obtained from an admixture of two or more salts is the resultant of the relative adsorption effects exerted by all the cations and anions involved. It will be seen therefore that, while $CaCl_2$ exerts an effect like an acid on account of its dominant cation, NaCl exerts an effect like an alkali on account of its dominant anion.

The remarkable correspondence between the ratios in which NaCl and $CaCl_2$ balance one another in these purely physical systems and in the biological systems referred to above led the writer to investigate further the relations exhibited by a variety of electrolytes known to exert antagonistic effects in biological systems. In several hundred experiments, full details regarding which will shortly be published, the writer has been able to duplicate the results obtained by Loeb, Osterhout, Lillie and numerous other biologists, on living cells. The ratios and proportions in which substances having a dominant cation antagonize substances having a dominant anion are approximately the same in the great majority of comparable physical and biological experiments. For convenience in describing experiments those substances having a dominant cation, which diminish the dispersion of the film in water, thus rendering the system less permeable to water, are termed "protective," those having a dominant anion, which increase the dispersion of the film in water, thus rendering the system more permeable to water, are termed "destructive." Even those substances like salts of Mg, and certain non-electrolytes, the anesthetics, which exhibit abnormalities in biological systems, functioning under varying

conditions and varying concentrations as protective or destructive agents, exhibit similar abnormalities when tested by means of the drop system described above. $MgCl_2$, for example, when employed in a drop system in conjunction with Na oleate, lowers the number of drops, exerting an antagonistic effect against NaCl virtually the same as that exerted by $CaCl_2$. When employed in a NaOH system, the $MgCl_2$ acts like NaCl, causing however a far greater rise in the number of drops than NaCl. This effect may be counteracted by means of $CaCl_2$ in proportions varying according to circumstances from one of $CaCl_2$ to one to four of $MgCl_2$. Anesthetics generally exert an effect like salts of Ca, and counteract the destructive effect exerted by NaCl on the film, but, under certain peculiar conditions and at considerably higher concentrations, they may exhibit a destructive effect on the film, causing an increase rather than a decrease in the number of drops. This result is of interest in view of the observation made by Lillie that anesthetics exert protective effects on *Arenicola* larvæ at certain concentrations, and destructive effects at other concentrations; particularly since the proportions in which given anesthetics exert an optimum protective effect on the drop film in our experiments, as indicated by the minimum number of drops, appear to correspond fairly closely with those observed by Lillie. These somewhat remarkable effects are being studied further in the hope of securing an insight into the exact nature of the mechanism involved. These experiments indicate that anesthesia is due to a diminution in the permeability of protoplasm. If the relative effects exerted by monovalent, divalent and trivalent cations are compared, it is found that Ca exerts from twenty to thirty times as great a protective effect on the film as Na, and Fe from 100 to several hundred times as great a protective effect as Na. Mono-, di-, and trivalent anions exhibit similar but less readily recognized ratios. Acids and alkalies exhibit the same peculiarities in these systems as in biological and colloidal systems, the H and OH ions being apparently much more active than other monovalent ions, and, in certain cases, exhibiting a greater activity than di- or trivalent ions. Weak acids and weak bases exert far less effect than strong acids and strong bases, and the ratios correspond fairly well with the probable concentration of the H or OH ion. The fact that NH_4OH exerts vastly less effect that NaOH, while in biological systems NH_4OH penetrates the protoplasm far more readily than NaOH, is readily explained when we remember that the penetration of NaOH depends upon a destructive effect exerted upon the protoplasmic structure resulting in an actual increase in the permeability of the system to water-borne substances, while NH_4OH presumably penetrates the protoplasmic system on account of its being dispersed or dissolved to a certain extent in the non-aqueous phase.

A single experiment has been selected from a comparative series carried out on animals, on the blood coagulation process, and on the drop system, in order to show that antagonistic electrolytes exert comparable effects in physical and biological systems. $CaCl_2$ and Na citrate were selected for this purpose, not because similar results could not have been obtained by the employment of $CaCl_2$ and NaCl, but because the high concentrations of NaCl required would have exerted a disturbing effect. By mixing a M/10 $CaCl_2$ solution with a chemically equivalent citrate solution in varying proportions, it was ascertained that they exert a compensatory or balancing effect upon one another in the various systems described, when present in the proportions of approximately one equivalent of $CaCl_2$ to two equivalents of Na citrate. $CaCl_2$ in excess of this proportion gave a number of drops less than that given by the original system, Na citrate in excess of this proportion gave a larger number of drops, but when $CaCl_2$ and the equivalent citrate solution were employed in ratios of 1:2, the number of drops obtained corresponded closely with that given by the original system. When the same solutions were injected into the tail veins of mice, it was found that the fatal dose of either the $CaCl_2$ or citrate solution alone was from .25 to .3 c.c. The amount required to cause the death

of the mice rapidly increased when citrate was admixed with $CaCl_2$, or when $CaCl_2$ was admixed with citrate, until finally, when the solutions were employed in the ratios of one equivalent of $CaCl_2$ to two of Na citrate, a destructive effect on the mice could only be observed when, by greatly increasing the concentration, the dose employed was raised to 40 or 50 times that used at either end of the scale. In the process of blood coagulation, all the plasma tubes employed were coagulated rapidly when $CaCl_2$ was present in excess of the ratio of 1:2, while no coagulation took place in those tubes in which the proportion of $CaCl_2$ was below this figure. From the remarkable similarity exhibited in these three systems, one purely physical, one purely biological, and one semi-physical and semi-biological, it may well be concluded that the equilibrium of both physical and biological systems of the type described depends upon the maintenance of the colloidal equilibrium of surface films, and that balanced solutions are those in which the proportions of cations or anions adsorbed on or reacting with the colloidal constituents of the film are compensatory, and consequently no change occurs in the equilibrium of the system.

These drop systems are peculiarly sensitive to changes in physical conditions and to slight variations, such, for example, as an increase or decrease in the proportion of fatty acid present in the olive oil employed. These variations are of peculiar interest as offering a possible explanation for the variations in permeability to food stuffs of actively growing cells, conditioned not only by variations in the proportions of electrolytes and of metabolic products in their environment, but also by slight variations in the proportions, for example, of lipase or any agent capable of splitting fats or lipoids. In fact these systems are as delicate, or even more delicate than living cells, and are equally difficult to work with. Accurate comparative data can only be obtained by the most scrupulous observance of every possible precaution to insure comparable working conditions, and by taking the average of a very large number of experiments. It is interesting to note in this regard that in such a series of experiments the great majority will lie within a close range of the average, while in certain individual experiments, as in the case of certain individual organisms, extraordinary abnormalities may be exhibited. It is not possible in this brief preliminary communication to explain fully the mechanism of the drop system, but it may be stated briefly that those forces which promote an increase in the number of drops are always comparable with those which promote the formation of emulsions of oil in water or a system more permeable to water, while those which exert the reverse effect causing a diminution in the number of drops are those which promote the formation of emulsions of water in oil or a system relatively less permeable to water. This is due presumably to the influence exerted by various reacting or adsorbed anions or cations on the relative dispersion of the constituents of the film in water, on the one hand, and oil, on the other, thus changing the relative surface tension on the two sides of the film, and promoting the formation according to circumstances of a system in which the permeability to water and water-borne substances is increased or diminished.

To turn now to the question as to how this bears on the problem of protoplasmic structure: it is probable that not only soap films, but all concentration films formed at the interface between two non-miscible phases, tend to be more or less similarly influenced by adsorbed substances. It is not proposed at this stage to consider the case in which the effects produced are simply due to an electric charge conveyed by adsorbed cations or anions, a subject which will be dealt with in a subsequent communication, but simply those cases in which definite soap films are formed and play a rôle in conditioning the equilibrium of the system. We know that fats and lipoids play an important rôle in the protoplasmic film. We know that soaps are present in the protoplasmic system, and, since the soaps in question will tend to concentrate, as has been seen above, at the interface between the particles of fatty or lipoid material and water, it is quite

conceivable that, when naked protoplasm comes in contact with an environing medium, like sea-water, capable of supporting life, the dispersed particles of fatty or lipoid material which find themselves immediately on the surface in contact with the sea-water are immediately influenced by the Ca in the sea-water. The system which consists of fatty or lipoid material, dispersed by means of a soap film in water, might be converted more or less perfectly into the reverse type of system, in which water is dispersed by means of a soap film in an external fatty or lipoid phase. The permeability of such a system to water, the extent to which water channels would be formed from point to point through such a film or membrane, might well depend on the proportions of those electrolytes like $CaCl_2$, on the one hand, which tend to render the system less permeable, and those like NaCl, on the other, which exert the reverse effect. Taking as an example the conversion of a dispersion of particles of wax in water into a honeycomb-like structure in which the water phase is surrounded by the continuous wax walls of the cells, it can readily be appreciated that any agent capable of corroding or perforating the walls of the honeycomb structure would promote the continuity of the previously dispersed water phase, and ultimately open up water channels of communication throughout the whole system. Agents capable of exerting the reverse effect, tending to protect the wax walls, would obviously antagonize the agents corroding or breaking down the walls, with the result that the permeability of such a system would depend ultimately upon the proportions in which the antagonistic agents in question are present in the system. The writer believes that a somewhat similar explanation might be found for the formation of the protoplasmic film, and that the antagonism between electrolytes possessing a more readily adsorbed cation, which tend to promote the formation of a less permeable system, and those possessing a more readily adsorbed anion, which tend to exert the reverse effect, may be accounted for on the lines indicated.

Proteins present in protoplasm being transformed under the influence of Ca into a non-reversible system analogous to a blood clot might well form a sort of framework and confer a certain rigidity, elasticity, and continuity to the membrane structure. Fatty or lipoid materials which produce readily reversible emulsion systems in conjunction with water, when supported by a protein framework, might yield a system sufficiently sensitive to exhibit variations in permeability to water under the influence of varying proportions of such antagonistic electrolytes as NaCl and $CaCl_2$.

CO_2, and other products of metabolism, exert a profound effect upon the equilibrium and relative surface tension relations of interfacial soap films, and it is hoped in a subsequent publication to demonstrate that, under the influence of variations in the proportions of products of metabolism and electrolytes at given points in the system, rhythmical variations in permeability may be produced in the protoplasmic film permitting of the intake of food stuffs and output of waste products, and functioning in a manner somewhat analogous to the valve system of an engine or machine. If we consider the analogy of such a valve system, since the efficiency of a mechanical system may be entirely destroyed by too greatly increasing or too greatly diminishing the size and speed of action of the valves, it is not difficult to understand how substances like $CaCl_2$, by diminishing the permeability, and substances like NaCl, by increasing the permeability of the protoplasmic membrane beyond those comparatively narrow limits within which vital functions may be performed, would ultimately cause a sufficient disturbance of colloidal equilibrium to bring about what we designate as the death of the cell. The variations in electrical potential exhibited between the inside and outside of the cell, and the electrical effects exerted by given salts correspond with this theory. These experiments with antagonistic electrolytes afford substantial support to the theory, first advanced by A. B. Macallum, that the similarity in the proportions of certain electrolytes in sea-water, the blood of mammals, etc., is attributable to the fact that living protoplasm

has inherited from its original protoplasmic ancestor an adjustment of colloidal equilibrium to those electrolytes which were present in sea-water at the time that protoplasmic material first came into being. In other words we may say that electrolytes play, and always have played, an extremely important rôle in conditioning the form and structure, and maintaining the equilibrium of the complex colloidal system which we designate as living protoplasm. For further details regarding these and other experiments, and the methods employed, reference must be made to a paper in the May number of the *Journal of Physical Chemistry* and to other papers which will shortly appear in the *Journal of Physical Chemistry*, the *American Journal of Physiology*, etc.

In conclusion the writer wishes to acknowledge his great indebtedness to Mr. F. West for his cooperation in the conduct of the experiments recorded in this communication.

G. H. A. CLOWES

THE ORGANIZATION OF THE PACIFIC PHYSICAL SOCIETY

THE first meeting of the Pacific Physical Society was called to order by Professor Fernando Sanford at 3 o'clock on March 4 in Room 370, Stanford University Quadrangle. Forty members of the various departments of physics, physical chemistry and chemistry of the Pacific coast universities were present.

Professor E. P. Lewis, of the University of California, was called to the chair, and the following program was presented:

The Electromotive Force produced by the Acceleration of Metals: RICHARD C. TOLMAN and T. DALE STEWART.

This paper described some experiments on the mass or inertia of the carriers of electricity in metals. Similar effects have been looked for by previous investigators, Maxwell,[1] Lodge[2] and Nichols,[3] without apparatus sensitive enough for the purpose.

A coil of wire was rotated about its axis and suddenly brought to rest. The two ends of the rotating coil were connected through an external circuit with a highly sensitive ballistic galvanometer and the deflection of the galvanometer noted when the coil was stopped, the pulse of electricity thus measured being produced by the tendency of the electrons in the wire to continue in motion after the rest of the coil was at rest. A number of serious accidental effects had to be eliminated.

From the results of the measurements it was possible to calculate the effective mass of the electron in copper, silver and aluminum, the values obtained being not far different from that of the mass of the electron in free space.

The authors believe that their results are in accord with the "free electron" theory of metallic conduction and present serious obstacles to Sir J. J. Thomson's[4] recent theory of the conducting process in metals.

Contact Electromotive Force of Amalgamated Metals: F. J. ROGERS.

Electromotive Force of Metallic Sulphide Electrodes: S. W. YOUNG and W. E. BURKE.

Change of Potential of the Same Metal in Different Electrolytic Solutions: PHILO F. HAMMOND.

Voltaic cells were formed by using platinum electrodes for both the cathode and the anode, but with different salt solutions surrounding each electrode, the two solutions being connected by a capillary tube or a gelatine partition. One tenth normal solutions were used in every case. Each

Metallic Ion in Nitrate Solution Used	When Measured Against Silver Nitrate	When Measured Against Potassium Nitrate	Single Electrode Potentials with Silver Reduced to Zero
Ag	0	0.658	0
Fe[5]	0.114	0.544	?
Cu	0.392	0.266	0.44
H	0.509	0.149	0.77
Pb	0.537	0.121	0.92
Ni	0.560	0.098	0.985
Co	0.565	0.093	0.99
Fe[6]	?	?	1.10
Cd	0.594	0 064	1.19
Zn	0.600	0.058	1.54
Mg	0.623	0.035	2.54
Ca	0.632	0.026	2.94
Ba	0.647	0.010	3.44
Na	0.653	0.005	3.90
K	0.658	0	3.94

[1] Maxwell, "Treatise on Electricity and Magnetism," 3d ed. (1892), Vol. II., pp. 211 *et seq.*

[2] Lodge, "Modern Views of Electricity," 3d ed. (1907), p. 89.

[3] Nichols, *Physik. Z.*, 7, p. 640 (1906).

[4] Sir J. J. Thomson, *Phil. Mag.*, 30, 192 (1915); see also Richardson, *Ibid.*, 30, 295 (1915).

[5] Ferric nitrate.

[6] Ferrous nitrate.

salt solution was measured against both silver nitrate and potassium nitrate.

After making certain corrections the above results were obtained from the measured differences of potential of the two electrodes.

Column three was derived from tables.

A curve was plotted using column one as abscissæ and column three as ordinates.

Notice that the ferric ion does not fall in the position usually given to iron, but in a position near the silver, actually between antimony and mercury.

The Pressure of Sound Waves: E. P. Lewis.

The Passive State of Iron in Nitric Acid: Joseph G. Brown.

It seems evident that the only hope of explaining the passive state of metals lies in the detailed study of the process by which some particular metal becomes passive in some particular solution. Accordingly such a study has been made for iron in nitric acid solutions. The E.M.F. of the primary cell: Iron/HNO_3 solution/concentrated HNO_3/platinum, has been measured at room temperature from the instant that it was made until it reached a steady state, using eight densities ranging from 1.01 to 1.41, both with the iron at rest and in motion. Observations were made with a low power microscope upon the changes which took place on and around the iron.

The results show that the ferrous oxide which forms on the iron at the start in all acid densities does not affect the E.M.F. of the cell, but the liquid products do. If the iron is kept at rest in acids up to 1.17 the E.M.F. is increased by the presence of the ferrous nitrate, while in acids denser than 1.17 the E.M.F. is lowered by some other product which forms a bright red liquid film over the oxidized surface of the iron. It is thought that this may be the unstable compound formed by the absorption of nitric oxide by ferrous nitrate, and the existence of this compound determines the semi-passive state.

In acids of greater density than 1.25 there is an explosive reaction between the ferrous oxide and the red liquid, after which the iron is in the passive state. The E.M.F. falls very quickly to a minimum and then rises very slowly to an extremely constant value.

It seems probable that both the ferrous and ferric reactions take place in acids of all densities, but in those greater than 1.25 the ferrous reaction may be quenched by the sudden reaction between the ferrous oxide and the red liquid, while the ferric reaction remains.

There is no indication of the existence of any kind of a film after the passive state is reached, but the gradual change in E.M.F. seems to indicate the expulsion of a gas from the iron after the state is reached.

If the explanation given is correct it allows the interesting conclusion that iron is "active" whenever the conditions are such that the ferrous ions are formed, but it is "passive" whenever these ions are not formed. This means that iron is essentially ferric and the chemical and electrical action of iron under ordinary circumstances is due to the existence, or formation, of ferrous iron at the surface. The E.M.F. measurements obtained would thus place ferrous iron in the electrode potential series between cadmium and cobalt, which is usually ascribed to iron, while ferric iron falls between antimony and mercury.

The fact that all those properties of iron which depend upon its cohesion make it more like platinum than like zinc, and the fact that comparisons of the potential of the same metal in ferrous and ferric salts place the ferrous and ferric iron in these same positions in the series, seem to confirm the conclusion.

If the significant thing about a valence is a number of electrons, it would seem that the surface molecules lost an electron under certain conditions but not under other conditions.

Conductivity of Paints: Raymond B. Abbott.

A Possible Method for the Detection of Gravitational Effect on Electrons: Lloyd T. Jones.

A Formula for Computing a Cohesion Constant: P. A. Ross.

At the Berkeley meeting of the American Physical Society in 1915 a paper was presented by the writer on the "Law of Cohesion in Mercury," in which it was found that the cohesion forces in mercury varied inversely as the sixth power of the distance. A value of the cohesion force was computed from the specific heat and coefficient of expansion which integrated on vaporization to a value agreeing well with the latent heat of vaporization.

In the present paper it is shown that from the principle of equipartition of energy in a vapor the same cohesion constant may be computed, the formula being

$$K = 7.5 \frac{p}{dD^{5/3}} \cdot \left(\frac{M}{N}\right)^{5/3},$$

where p is the vapor pressure; M, molecular weight; N, number of molecules per gram molecule; d, density of the vapor; D, density of the liquid; K, cohesion force between a vapor molecule and the liquid surface.

From this equation another constant, F, representing the force between two *single molecules* was found to be given by the equation

$$F = \frac{pM^{2/3}}{dD},$$

where the letters have the same meanings as before. At the critical point this becomes

$$F = \frac{pM^{2/3}}{D^2}.$$

This constant is directly proportional to the constant "a" in Van der Waals's equation and nearly proportional to the Rankine, Heydweiller and Kleeman constants.

A New Automatic Mercury Pump: W. P. ROOP and L. T. JONES.

Two Small Communications on Galvanometers: W. P. ROOP.

(*a*) The reduction factor and resistance of a sensitive galvanometer may be quickly and conveniently determined by means of a decade bridge. Galvanometer and battery are connected to the appropriate binding posts, as in the ordinary use of the bridge. The binding posts to which the unknown resistance is ordinarily connected are left free. Two settings of rheostat resistance and the corresponding galvanometer readings yield the required result.

Approximations are as follows: One ratio arm is neglected in comparison with the other. Battery resistance is neglected in comparison with that of the high ratio arm. Battery E.M.F. is taken as constant. The deflections of the galvanometer are supposed proportional to current. Failure to meet this last condition can be remedied by applying a process of successive approximation to the calculations.

(*b*) The sensitiveness of a galvanometer may be doubled by doubling the scale distance and placing the telescope close to the mirror. As compared with other means of increasing the sensitiveness[7] this scheme has the following advantages: It requires no change in the galvanometer. It brings the observer close to the instrument. It enlarges, rather than diminishes, the field of view, or, if desired, permits the use of a smaller mirror. It introduces none of the difficulties of the other method which arise in multiple reflection.

[7] Geiger, *Physikalische Zeitschrift*, January, 1911.

Some Properties of Thin Films: W. P. ROOP.

An attempt to observe a change in ohmic resistance of a thin film on illumination with ultraviolet light resulted negatively. Such a change might be anticipated as a result of photoelectric emission. Diminution in density of free electrons might increase resistance, or liberation of bound electrons might result in decrease.

Other phenomena were observed, however, for which no simple explanation has been found. These include: (*a*) Spontaneous change in resistance of the film. (*b*) Negative temperature coefficient. (*c*) A quasi-polarization effect. The film was connected like a condenser, first with a dry cell, and then with a galvanometer. The galvanometer showed ballistic deflections which diminished approximately logarithmically with increasing time interval between disconnection from cell and discharge. The half-value period was about two seconds. (*d*) Fluctuations in the resistance of the film. In a typical case, there was a variation of the order of 1 per cent. in the resistance of a film of 2×10^6 ohms. The fluctuation was entirely spontaneous, uninfluenced by small temperature changes and by the nature of the gas in contact with the film. It covered a wider range at higher resistances.

Oxidation has an undoubted effect on the phenomena observed. All were present, however, in high vacuum and hydrogen as well as in air. Substances most used were nickel and zinc. Observable tarnish of the surface was in no case apparent.

A recess was declared at 6 o'clock in order to enjoy a delightful dinner, served in the Faculty Club house on the campus. After the dinner members listened to the paper by Professor Sanford.

The Specific Inductive Capacity of Certain Metals: FERNANDO SANFORD.

It is well known that in the spectra of a number of metals series of lines have been found whose wave-lengths may all be computed from a simple formula. In all these cases the wave-lengths converge towards a shortest possible wave-length for the series. In the group of the alkali metals a spectral series whose convergence wave-length is shorter than any known wave-length in the spectrum of the respective metal is known for each element. It is assumed in the paper that these convergence wave-lengths represent the shortest wave-lengths that can exist in their respective

atoms, and that the orbital radius of the electron whose vibration frequency would give the convergence number is the true radius of the central positive atom.

Heydweiller has computed the atomic diameter of a large number of elements from the volume occupied by their dissociated ions in a very dilute water solution. Heydweiller's atomic radii are accordingly here taken as the orbital radii of the electrons whose vibration frequencies would give the convergence numbers of Kayser's "Principal Series" in the alkali metals, and the centripetal forces required to hold these convergence electrons in their orbits are calculated. Then, assuming the inverse square law for the attraction between an electron and its central positive charge, the force of attraction upon an electron at unit distance from the center of its orbit is calculated for each element.

If the central positive charges of the atoms were the same for different elements, then these central forces should be the same. They are found not to be the same.

The positive charges of these atoms have previously been computed by the writer from electrolytic data. The charges here computed are not proportional to those formerly computed, hence the assumption that the atoms of the different elements have different specific inductive capacities seems to be justified. These specific inductive capacities may be computed by dividing the charges of the atoms by the respective forces which they exert upon an electron at unit distance.

The specific inductive capacities are calculated in this way for the thirteen elements for which convergence numbers, atomic radii and atomic charges have been computed. Since it is only for the alkali metals that the convergence numbers used are known to belong to the principal, or inner, spectral series, it is only to these elements that we can be sure that the above arguments apply. However, the computed specific inductive capacities are proportional to the serial numbers of Rydberg for ten of the thirteen elements, and for the other three, viz.; zinc, cadmium and thallium, they increase with the serial numbers just half as fast as they do in the case of the other elements.

The specific inductive capacities here computed are also shown to vary with the same atomic properties which vary with the measured specific inductive capacities of non-metallic elements.

It is also shown that the specific inductive capacities of these elements are proportional to their respective atomic radii. This would make the centripetal force upon electrons revolving about and very near to these different atoms proportional to the inverse third power of their orbital radii. This is shown to be the relation that must hold in order that the kinetic energy of different electrons shall vary as their frequency, as is assumed in Planck's Law and is apparently shown in the case of electrons expelled by the action of ultra-violet light upon metals.

The *relative* specific inductive capacities which have been calculated as above are given in the following table:

Element	k	Element	k	Element	k
Li	35.9	Mg	134	Zn	190
Na	127	Ca	196	Cd	255
K	238	Sr	412	Tl	350
Rb	437	Ag	466		
Cs	567	Cu	346		

Attention is called to the fact that if the orbital radius of the outermost electron of a series be taken as the atomic radius instead of the orbital radius of the innermost electron, it will not change the order of values of the specific inductive capacities calculated as above.

Following the discussion of this paper, the question of a Pacific coast organization was taken up. The chairman of the meeting reported that favorable replies had been received from the science instructors at the universities in Washington, Oregon and Utah. It was decided to form an informal organization to be known as the Pacific Physical Society, looking toward the formation of a section or branch of the American Physical Society in the near future.

Ralph S. Minor,
Permanent Secretary

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and eighty-fourth regular meeting of the society was held at Columbia University on Saturday, April 29, 1916. The attendance at the two sessions included fifty-one members. President Brown occupied the chair, being relieved by Vice-president E. R. Hedrick. The council announced the election of the following persons to membership in the society: Dr. E. T. Bell, University of Washington; Professor T. R. Eagles, Howard College; Mr. Glenn James, Purdue University; Dr. J. O. Hassler, Chicago, Ill.; Professor G. N. Watson, University College, London; Mr. J. H. Weaver, West Chester, Pa. Six

applications for membership in the society were received. Professor D. R. Curtiss, of Northwestern University, was reelected a member of the editorial committee of the *Transactions*, to serve for three years, and Professor L. P. Eisenhart, of Princeton University, to serve on the same committee in place of Professor Dickson for one year.

The twenty-first summer meeting and eighth colloquium of the society will be held at Harvard University, September 4–9, 1916. Two courses of colloquium lectures, each five in number, will be given by Professor G. C. Evans, of Rice Institute, on "Topics from the theory and applications of functionals, including integral equations," and Professor Oswald Veblen, of Princeton University, on "Analysis situs." The year 1916 marks the twenty-fifth anniversary of the broadening out of the society into a national organization and of the founding of the *Bulletin*. It is proposed to arrange an appropriate celebration of this event at the summer meeting. Some seventy-five of those who were members of the society in the year 1891 have retained their membership through these twenty-five years. It is hoped that the celebration may itself become a notable milestone in the society's history.

Committees were appointed to consider the question of the publication of the Harvard Colloquium Lectures, and to consider in cooperation with committees of other scientific bodies the matter of the classification of technical literature. A committee was also appointed to draw up a list of nominations of officers and other members of the council to be elected at the annual meeting next December.

The following papers were read at this meeting:

Samuel Beatty: "Derivation of the complementary theorem from the Riemann-Roch theorem."

J. F. Ritt: "The resolution into partial fractions of the reciprocal of an entire function of genus zero."

J. F. Ritt: "Linear differential equations of infinite order with constant coefficients."

C. J. Keyser: "Concerning autonomous doctrines and doctrinal functions."

Edward Kasner: "Element transformations of space for which normal congruences of curves are invariant."

J. H. Weaver: "Some extensions of the work of Pappus and Steiner on tangent circles."

J. L. Coolidge: "New definitions for Plücker's numbers."

G. C. Evans: "Integral equations whose kernels satisfy a certain difference equation in variable differences."

Dunham Jackson: "An elementary boundary value problem."

L. P. Eisenhart: "Transformations of conjugate systems."

A. A. Bennett: "An existence theorem for the solution of a type of real mixed difference equation."

A. A. Bennett: "A case of iteration in several variables."

R. W. Brink: "Some integral tests for the convergence and divergence of infinite series."

Glenn James: "A theorem on the non-summability of a certain class of series."

F. J. McMackin: "Some theorems in the theory of summable divergent series."

J. R. Kline: "A definition of sense on plane curves in non-metrical analysis situs."

H. B. Fine: "On approximations to a solution of a system of numerical equations."

B. H. Camp: "Fourier multiple integrals."

G. A. Pfeiffer: "On the conformal mapping of curvilinear angles."

G. C. Evans: "Proof of Green's theorem by approximating polynomials."

A. R. Schweitzer: "On a type of quasi-transitive functional equations."

J. W. Alexander: "Some generalizations of the Jordan theorem."

C. E. Wilder: "Expansion problems of ordinary linear differential equations with auxiliary conditions at several points."

E. V. Huntington: "A simple example of the failure of Duhamel's theorem."

W. F. Osgood: "Note on functions of several complex variables."

F. N. COLE,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 553d regular meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, March 25, 1916, called to order by President W. P. Hay at 8 P.M., with 40 persons present.

The president called attention to the recent death of Henry Talbott, a member of the society.

Under the heading Brief Notes and Exhibition of Specimens, General Wilcox exhibited lantern slide views of the country along the Mexican border of the United States.

Under the same heading Mr. A. A. Doolittle exhibited a specimen of *Amblystoma punctatum* from the District of Columbia.

Dr. O. P. Hay exhibited a mutilated braincase of an elk which had caused certain persons much difficulty to identify; he also showed a remarkably well preserved skull of an extinct horse.

President Hay exhibited a number of lantern slides of biological interest, chiefly of aquatic animals in the vicinity of Beaufort, North Carolina.

Medical Inspector Ames asked if any member present had positive knowledge as to the ability of camels to swim, or otherwise? This question was discussed by several members, but no positive knowledge was forthcoming. He also inquired as to the possible existence of a South American animal with dorsally placed mammæ.

Following the adjournment of the society several members examined a microscopic preparation of a living embryo of *Filaria bancrofti* obtained by Dr. Lyon from a former inhabitant of British Guiana but for several years resident in the District of Columbia.

The regular program was as follows:

W. P. Hay: "Notes on the Growth of the Loggerhead Turtle," illustrated by lantern slides and chart. Mr. Hay gave an account of two young loggerhead turtles now under observation at the U. S. Fisheries Biological Station at Beaufort, N. C. They are the survivors of a lot of 77 hatched September 9–11, 1912, from eggs obtained from a nest on Bogue Bank about six weeks earlier. When first hatched the average size of the young was: total length 77.3 mm.; length of carapace, 46.2 mm.; weight, 20.1 grams.

At the age of three years the survivors measure 493 and 515 mm., in total length; 343.75 and 365 mm., in length of carapace; and weigh 6,690 and 7,967 grams, respectively. The increase in size and weight has been steady and the measurements, which have been taken twice a year, can be plotted as points on a curve. This curve continued indicates that the maximum size of this species, about 1,000 mm. length of carapace, may possibly be obtained in the tenth or eleventh year, and that sexual maturity is probably reached in the sixth or seventh year. This is considerably more rapid growth than has usually been attributed to animals of this kind.

The paper was discussed by Dr. Shufeldt, Dr. O. P. Hay, Medical Inspector Ames, and Mr. Doolittle.

R. W. Shufeldt: "The Restoration of the Dinosaur, *Podokesaurus holyokensis*." Dr. Shufeldt gave an historical account of a discussion upon the restoration of the dinosaur *Podokesaurus holyokensis* of Talbot, which took place in the autumn of 1915. This discussion was carried on in correspondence and participated in by Drs. Richard S. Lull and Mignon Talbot, Hr. Gerhard Heilmann, and the speaker. Lantern slide illustration and blackboard demonstration were employed to point out what was held to be inconsistencies in the restoration of this animal, as figured in Dr. Lull's "Triassic Life of the Connecticut Valley" (Fig. 31). Drs. Lull and Talbot contend that the pubic element in the matrix of *Podokesaurus holyokensis* occupies the position in relation to the other bones of the skeleton that obtained in life. Dr. Shufeldt and Hr. Heilmann controvert this decision by pointing out that all the bones in the slab containing the remains of this dinosaur are far removed from their normal articulations; and that, if the pubic element were articulated as Dr. Lull has figured it, it would have come, in life, forcibly in contact, anteriorly, with the sternal ribs and been a constant menace to the abdominal viscera in various movements of the animal.

R. E. Coker: "A Biological and Fish Cultural Experiment Station," illustrated by lantern slides. Mr. Coker said that since biologists, at least, are generally familiar with the functions of the Fairport Biological Station in the propagation and study of the fresh-water mussels, particular attention was given to the purposes of that station in experiment work relating to the rearing of fishes.

As in horticulture the problems of the nurseryman and those of the fruit grower are distinct, so in fish-culture, and in fish-cultural experiment work there is the phase of the hatchery with its product of fry and fingerling, and that of the fish farm where it is intended to rear fish to adult size in commercial quantities. The Fairport station is concerned with problems of rearing rather than of hatching. The grower of fish has problems similar to those of the stock farmer or the poultry raiser, while in addition he must take thought for conditions affecting the respiration of fish. He can not always regulate the numbers of fishes in his ponds by direct means, but may have to accomplish this end by proper association of species. It may even be necessary to group together species which are to an extent "incompatible."

The problem of the fish pond has its mechanical, physical, chemical and zoological aspects; more especially, however, it is a problem of appropriate vegetation, promotion of food supply, and proper association of species of fish.

M. W. Lyon, Jr.,
Recording Secretary